

THE UNIVERSITY OF TEXAS AT AUSTIN

Date: 09/05/2014

**RECOMMENDATION FOR CHANGE IN ACADEMIC RANK/STATUS**

Name: Todd Humphreys EID: th9536 Present Rank: Assistant Professor

Years of Academic Service (*Include AY 2014-15 in each count*):

At UT Austin since: 09/01/2009 In Present Rank: 6.00 In Probationary Status (TT only): 6  
(month/day/year) (# of years) (# of full years)

Primary Department: Aerospace Engineering and Engineering Mechanics College/School: Cockrell School of Engineering

Joint Department: - College/School: -

Other Department(s): Applied Research Laboratories

Recommendation actions<sup>1</sup>:

By Budget Council/Executive Committee: Promote

Vote<sup>2</sup> for promotion 21; Against 0; Abstain 0; Absent 1; Ineligible to vote 0

By Department Chair: Promote

By College/School Advisory Committee: Promote

Vote for promotion 6; Against 1; Abstain 0; Absent 0

By Dean: Promote

Administrative Action: Promote to Associate Professor

Date Action Effective: September 1, 2015

(To be submitted to the Board of Regents as part of the annual budget.)

By:   
Todd Humphreys  
For the President

Date: December 17, 2014

<sup>1</sup>See "Chart of Recommended Actions" for eligible recommended actions applicable to specific conditions and administrative levels.

<sup>2</sup>Record all votes for and against promotion, abstentions by eligible voting members, and the number of absent eligible voting members. The number of budget council/executive committee members ineligible to vote due to rank should also be recorded. Enter zero where it would otherwise be blank.



**THE UNIVERSITY OF TEXAS AT AUSTIN  
COCKRELL SCHOOL OF ENGINEERING**

*Office of the Dean • 301 E. Dean Keeton Street, C 2100 • Austin, Texas 78712-2100*

**Dean's Assessment**

Todd E. Humphreys

Department of Aerospace Engineering and Engineering Mechanics

Todd Humphreys received his BS and MS degrees in Electrical and Computer Engineering from Utah State University in 2000 and 2003, respectively, and a PhD degree in Aerospace Engineering from Cornell University in 2008. Following graduation, Dr. Humphreys served as a researcher and co-founder of Coherent Navigation for one year before beginning his tenure-track appointment as assistant professor in the Department of Aerospace Engineering and Engineering Mechanics at the University of Texas in Austin in August 2009. If successfully promoted to associate professor, Dr. Humphreys will have served in the rank for six years.

Ten external references were submitted as part of the promotion dossier, six chosen by the candidate and four by the department's budget council. One referee did not respond and another referee declined, indicating that he has too many commitments. Nine full professors from a broad range of departments at domestic and international institutions submitted letters, representing Stanford, Illinois, University of Colorado Boulder, University of California Riverside, Miami, Illinois Institute of Technology, University of New South Wales, University of New Brunswick, and University of Calgary. Although not all the letter writers are associated with peer institutions, most of the letter writers hold chaired professorships and are well recognized through their professional awards. One letter is written by a member of the National Academy of Engineering.

**Teaching**

Dr. Humphreys teaches courses in spacecraft dynamics and GPS-based navigation. Since joining UT, he has taught a total of ten classes (five different courses), including two undergraduate classes [ASE 366K, *Spacecraft Dynamics* (two times) and ASE 372N, *Satellite-Based Navigation* (three times)] and three graduate classes [ASE 389P7, *Global Positioning System* (three times); ASE 396, *Model Based Detection/Estimation* (one time); and ASE 381P8, *Stochastic Detection, Estimation and Control* (one time)]. Enrollment has ranged from 14 to 75 students in his undergraduate classes and from 5 to 24 in his graduate classes. Dr. Humphreys' average course instructor ratings range between 4.6 and 5.0 and his course ratings range between 4.3 and 4.9. His overall course instructor rating is 4.5 and his overall course rating is 4.63. Both are above the department and school averages.

Annual peer reviews conducted by full professors covering all courses taught by Dr. Humphreys are included in the dossier. All evaluations are very positive. It is clear that Professor Humphreys is a very enthusiastic instructor who is "a master of the course material and very much at home in the classroom" (Prof. Fowler). Professor Humphreys "has an engaging personality and is a charismatic teacher... I have been teaching for over 40 years and I think I learned a few things today..." (Prof. Hughes). Graduate courses taught by Professor Humphreys draw students from other departments especially electrical and computer engineering. The students' comments support the peer assessments.

The exemplary nature of Dr. Humphrey's teaching has been recognized by the UT System with the 2012 Regents' Outstanding Teaching Award and the Cockrell School of Engineering with the 2012 Dean's Award for Outstanding Teaching by an Assistant Professor.

**Research**

Dr. Humphreys' research is in the emerging area of the satellite navigation with thrusts in secure and robust perception, precision positioning and orientation for consumer mobile applications, and instrumentation for remote sensing. Dr. Humphreys directs the Radionavigation Laboratory, which is known for its research on secure

perception. Furthermore, his research influenced broad public policy related to the vehicles using Global Positioning Systems (GPS).

While in rank, Dr. Humphreys has published 16 refereed archival journal papers (13 are based on work at UT and three are based on his PhD work at Cornell). His career total is 18. These papers have appeared in selective journals, including *Navigation*, *Journal of the Institute of Navigation*, *Journal of Field Robotics*, *IEEE Transactions on Aerospace and Electronic Systems*, *International Journal of Critical Infrastructure Protection*, and *IEEE Journal of Selected Topics in Signal Processing*. He also has 34 refereed conference papers in rank (43 career total). Dr. Humphreys has also published twelve articles in the popular press, including *Scientific American* and *GPS World*. Using Google Scholar, his publications have been cited over 900 times and his h-index is 19. Dr. Humphreys holds two patents on work completed before he joined UT, and has submitted one patent application related to work at UT.

In 2012, Dr. Humphreys testified before the US House of Representatives Committee on Homeland Security and participated in a field forum sanctioned by the House Judiciary Subcommittee on Crime, Terrorism, and Homeland Security. He has also given 29 invited talks (including three keynote lectures) and one TedX talk.

Dr. Humphreys has received 14 external research grants, and he is UT lead on 13. He received direct federal funding from the Department of Defense (DTRA) and the US Air Force. He also has received industrial funding from Boeing, Lockheed Martin, Northrop Grumman, Harris, and Samsung. He has participated in three STTR awards (two to Coherent Navigation<sup>1</sup> and one to ASTRA) with funding from the US Navy and US Air Force. His collaborative research project is a US Department of Transportation center that includes researchers from the Center for Transportation Research and the Wireless Networking and Communications Group (WNCG). He has also received research gifts through WNCG and is an unfunded member of the research team for a project supported by the College of Natural Sciences Catalyst Grant Competition. Dr. Humphreys' total research funding is more than \$4.5 million, and his share is more than \$1.8 million (more than \$1.7 million is external).

The external references highlight the high quality and impact of Dr. Humphreys' research and indicate that he has developed an international reputation for his work. While some of the referees are not associated with peer institutions, the budget council noted that this is "the nature of the global-navigation field since few of the top schools have strong researchers working in this area."

Dr. Penina Axelrad (Colorado) writes, "His influence on the field of GPS security is quite remarkable for a faculty member at such an early stage in his career. Dr. Humphreys has published the **most highly cited articles** describing the threat spoofing to GPS use and innovative detection strategies to insure the validity of position and timing solutions. He is widely recognized and his work highly valued because he has addressed this important issue through both analytical developments and experimental demonstrations." "It is clear from his scholarly progress thus far, and the high level of engagement and leadership he already has in the GNSS community, that Dr. Humphreys has great promise to be a significant contributor and thought leader in the future."

Dr. Per Enge (Stanford University, NAE) writes, "Dr. Humphreys has a bright future. The field of navigation security has just opened in the civilian community and will be a strong research area for the next ten to fifteen years. Dr. Humphreys will certainly be a leader in this vital and interesting effort. More importantly, his technical work shows deep underlying knowledge of signal processing, detection and estimation theory, and experimental work."

Dr. Farzad Kamalabadi (Illinois) writes "... it became apparent that Professor Humphreys' expertise in positioning, navigation, and timing (PNT) solutions reach far beyond only the security and authentication

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<sup>1</sup> Dr. Humphreys is a co-founder of Coherent Navigation.

aspects and cover diverse areas such as robust and energy-efficient next-generation GNSS receiver design and engineering, PNT coverage and integrity, and privacy. Professor Humphreys' breadth and depth in these areas impressed many of my senior collaborators and colleagues, which included several members of the National Academies.” “In summary, on the basis of the analysis I have provided above, I enthusiastically endorse Professor Humphreys’ advancement to the rank of Associate Professor with tenure at UT Austin.”

Dr. Gerard Lachapelle (Calgary) writes, “The above accomplishments have occurred over a short period of 5 years. His development compared with others at research-intensive universities places him positively in the top 5% of his cohort. I firmly believe that his potential for further professional growth is exceptional. He already established himself as a leader in the area of GNSS. In conclusion, I find Professor Humphreys’ research and professional records outstanding.”

#### Advising and Student Mentoring

Dr. Humphreys has served as co-supervisor for two PhD students (one is now an assistant professor at UC Riverside). Both students were co-supervised with faculty in the Department of Electrical and Computer Engineering. He also co-supervised two MS students with faculty in his department. Finally, he has supervised three undergraduate students (two with an honors thesis). Currently, he is supervising five PhD students (one is co-advised). Dr. Kamalabadi (Illinois) commented that Dr. Humphreys “has been very effective at graduate student advising and mentoring, as evident by awards they have received while under his supervision.” Dr. Pervan (Illinois Institute of Technology) noted that “his graduate students’ presentations at conferences are always prepared to the highest standards.”

#### University Service

Dr. Humphreys’ university service is modest, but not unusual for an assistant professor. He has served as the faculty advisor for the UT student chapter of the American Institute of Aeronautics and Astronautics (AIAA) for several years. He is also a contributing member of the Wireless Networking and Communications Group. He served on one committee within the Cockrell School of Engineering.

#### Professional Service

Dr. Humphreys serves as editor of the *IEEE Transactions on Wireless Communications*, one of the five highest-impact IEEE journals. He also served on the executive committee of the Institute of Navigation as land representative (2013-present) and as track and session chairs for various professional conference and workshops.

#### Other Evidence of Merit or Recognition

Dr. Humphreys has been recognized for his scholarly contributions by a variety of different organizations. In 2012, he received GPS World Magazine Leadership Award. His students received Best Overall Paper and Best Student Paper Awards at IEEE/ION PLANS Conference in 2012. Finally, he won The University of Texas System Regents’ Outstanding Teaching Award (2012) and the Cockrell School Dean’s Award for Outstanding Teaching by an Assistant Professor (2012).

He has testified before the US Congress regarding unmanned aerial vehicle security and privacy issues, has advised the Central Intelligence Agency and the GPS Directorate of the US Air Force on the civil vulnerability to GPS deception, and directly contributed to Texas House Bill 912, which protects privacy by setting limits on the use of drones. Furthermore, Dr. Humphreys’ work has received extensive coverage in the popular press through a TED talk (over 600,000 views), three panel sessions at SXSW, and media outlets such as NPR, BBC, PBS, CBS, CNN, FOX, ABC, CSPAN, and the New York Times.

Overall Assessment

In summary, Dr. Humphreys is an outstanding teacher and recognized researcher. He has been very successful in building his UT Radionavigation Laboratory and securing research funding. All external reference letters were supportive and uniformly recommend promotion.

Several aspects of Dr. Humphreys' case raised concerns among the promotion and tenure committee.

- (1) Dr. Humphreys had not received a competitive federal grant, which is the traditional means for assistant professors to demonstrate the sustainability of their research funding. I am not concerned by this aspect of his case. He has secured funding from a variety of federal and industry sources, and the impact of his research has not been limited. As federal funding becomes more difficult to secure, we must be more flexible in this respect.
- (2) All four of Dr. Humphreys' students who completed their graduate degrees have been co-supervised. If he had co-supervised the students with the same faculty member(s), I would possibly be concerned about his ability to develop an independent research program, but each student was co-supervised by a different faculty member (two in ECE and two in ASE). In addition, only one of his current students is co-supervised.
- (3) He has received extensive coverage of his work in the popular press, which may imply that his work is too applied or lacks scientific merit. The external reviewers addressed the technical merits and original nature of his work. In addition, one of our goals within the Cockrell School is to promote the impact of our ongoing research. Dr. Humphreys enhances our efforts in this area.

Therefore, I believe that Dr. Humphreys meets or exceeds all expectations for promotion to associate professor and support this case without reservation.



Sharon L. Wood, Dean  
9 November 2014



DEPARTMENT OF AEROSPACE ENGINEERING AND ENGINEERING MECHANICS  
THE UNIVERSITY OF TEXAS AT AUSTIN

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**Chair's Statement on Promotion of Dr. Todd Humphreys to Associate Professor**

**Budget Council Recommendation**

The Department Budget Council (BC), consisting of all full Professors in the department, met on August 28, 2014 to discuss our department's promotion and tenure cases. The promotion dossiers of the candidates, including the BC sub-committee reports, were made available to the BC in electronic form (UTBox) three days prior to the meeting. After the meeting, a vote was conducted by secret electronic ballot and members were given until September 2 at noon to submit their votes. Of the 22 BC members (including the Department Chair), 18 attended the meeting and participated in the discussion. The BC members who could not attend the BC meeting had access to the full promotion dossier.

At the meeting, the subcommittee (Demkowicz, Goldstein, Schutz) report was presented by Prof. Demkowicz and he focused on research, teaching, service and honors/awards. Demkowicz discussed that Humphreys works in three main areas of (i) GPS security, (ii) estimation and signal processing, and (iii) ionosphere effects on global navigation and instrumentation. His research is highly interdisciplinary, as he straddles the fields of space engineering and wireless communications. In fact, he is a member of the Wireless Networking Group in ECE and collaborates extensively with their faculty. His research related to the ionosphere stems from his PhD research, but the other areas he has developed since coming to UT. Demkowicz pointed out that Humphreys work in GPS security has been very influential, and the potential for spoofing GPS signals was first pointed out by him in an Institute of Navigation (ION) Meeting in 2008. This paper is the highest cited paper in the field of navigation and timing security. Demkowicz also mentioned that the impact of Humphreys' work on GPS security has had a major impact in the field, but has also influenced public policy. Humphreys testified in front of Congress several times on the threats associated with drones navigating with GPS in civilian airspace, and the potential for them being commandeered by hackers or terrorists. It was also mentioned that Humphreys has given a very popular TedX-Austin talk on this same topic, which has over 600,000 views. In the BC discussion, some questioned the technical impact of a Ted talk, but Kyriakides commented that anyone who watches the Ted talk on YouTube would be impressed by the high-level of the technical content and the importance of the topic.

Demkowicz then began a discussion of Humphreys' research productivity statistics. In rank, Humphreys has published or had accepted 14 papers in the top journals in the field, and 34 refereed conference papers, including three that won best paper awards. (Note that since the time of the BC vote, two of his papers were accepted and so the correct count is 16.) He has also been invited to give 3 keynote lectures at international conferences. Humphreys has already graduated two PhD students (both co-supervised), one of whom has taken a faculty position at UC Riverside. Google Scholar gives 933 citations of his work and an h-index of 19. Note that

Google scholar includes citations from conference journal articles, conference papers and conference abstracts, and so tends to give a higher number of citations than ISI. He has secured funding of \$1.8M (his share), and he has been the PI on 13 of 14 of his grants. His funding sources are quite broad and include grants from Samsung, Boeing, Northrup Grumman, Harris Corp., Astra Space, Coherent Navigation, Sandia, US Air Force and the Dept. of Transportation. His extensive funding from industry shows the importance of his work to the development of current technology. He also has three patents, two of which were awarded in rank. His productivity statistics were compared to previous successful promotion cases in our department, and it was concluded that his numbers are quite consistent with the norms of the department. A more direct comparison will be made in the chair's assessment below.

The subcommittee showed excerpts from each of the 10 external letters. There was some discussion about the quality of institutions from which the letters were solicited, since not all of the universities are our peers. I pointed out that this is the nature of the global-navigation field since few of the top schools have strong researchers working in this area. Furthermore, we did ask for letters from someone at Ohio State and another professor at Stanford, but one declined and the other didn't respond. I further pointed out that we did receive letters from peer schools (Stanford, UIUC, Purdue, UC Boulder [the 9th ranked ASE department]) as well as three international institutions (UNSW, U. Calgary, U. New Brunswick) to attest to Humphreys' international reputation. Also, although UC Riverside, Miami, and IIT are not peer schools, the reviewers are all recognized leaders in their fields. Farrell (UC Riverside) is a fellow of both the IEEE and AAAS and a former department chair, Morton (Miami U) is a fellow of the IEEE, and Pervan (IIT) is a fellow of ION and Editor-in-Chief of *Navigation*. Demkowicz commented that the letters all strongly supported Humphreys and the committee could find no negative or even neutral comments. There was some discussion as to whether one comment by Enge (Stanford) could be interpreted as negative. Enge wrote: "At Stanford, we presently have five Assistant Professors on the tenure track in the Department of Aeronautics and Astronautics. Dr. Humphreys compares well to this group." Someone commented that if these assistant professors were not very good then this is not a ringing endorsement. I commented that given my experience as a PhD student at Stanford, I am quite sure that this is an example of Stanford arrogance. Stanford believes they hire the best faculty in the world, and so if Humphreys compares favorably to their faculty, then Enge is implicitly giving very high praise. Tom Hughes, who is a former Stanford professor, agreed with this interpretation.

Regarding teaching, Demkowicz commented that Humphreys mainly teaches courses in spacecraft dynamics and GPS-based navigation, and that it is quite clear that he is one of the Cockrell School's best teachers. In his undergraduate courses he earned overall instructor ratings ranging from 4.6 to 5.0, and in graduate courses they ranged from 4.7 to 4.9. His average ratings are well above CSE averages. Demkowicz commented that he has never seen such positive comments from students, including a large fraction of who stated that Humphreys is the best teacher that they have had at UT. Humphreys' peer evaluations were similarly very positive. Demkowicz pointed out that in 2012 Humphreys won both the University of Texas System Regents' Outstanding Teaching Award and the CSE Dean's Award for Outstanding Teaching by an Assistant Professor.

Demkowicz also discussed Humphreys' service activities, which included his congressional testimony and his service as an advisor to the Department of Homeland Security, the USPTO on advances in GNSS, the National Executive Committee on Position Navigation and Timing, the CIA, and the GPS Directorate of the Air Force. Humphreys was also lead organizer for the 2013 Texas Wireless Summit and the 2010 Experts Meeting on Civil GPS Security. Humphreys has also recently been named associate editor of IEEE Transactions on Wireless Communications, which is a testament to his respect in the community.

Overall, the BC agreed that Humphreys' quantitative measures for research (publications and funding) met the standards for promotion. Some felt than when considering his teaching excellence, and the high impact of his work, he far exceeds the standards for promotion.

The BC voted unanimously (21 For, 0 Against, 0 Abstain, 1 Absent) in favor of promotion. The chair's vote is not included in this tally. This vote represents a very strong endorsement by the BC for the promotion of Todd Humphreys to Associate Professor with tenure.

### **Chair's Assessment**

A comparison of Humphreys' research productivity to his peers at other institutions is complicated by the fact that there are few associate professors at top schools who work in the same area as he does. However, I have selected three people at peer institutions to compare to: J.L. Garrison (Purdue), J.J. Makela (UIUC) and D. Gebre-Egziabher (Univ. Minnesota). These individuals are either associate professors or in the case of Makela, a recently-promoted full professor. I have compared some productivity metrics in Table 1. In the table I show career papers, citations and *h*-index, and in the last two columns an apples-to-apples comparison for their productivity metrics when they went up for promotion to associate professor. I compiled the data using ISI Web of Science, and I included both journal articles and proceedings papers since ISI will ignore legitimate journal papers if they are tied in any way to a conference. In doing this, it raises all of their paper counts, as we see with Humphreys who is credited with 39 papers. Also, the citation count for ISI is lower than for Google Scholar because Google Scholar includes many more items including non-refereed conference presentations and abstracts. Admittedly, Google Scholar is likely a better representation of impact for fast-moving fields where it is beneficial to present at conferences to quickly disseminate new results, but in my opinion it is harder to control what data are being used and so apples-to-apples comparisons are more difficult.

If we compare the last two columns, which show statistics for each person's time as an assistant professor, we see that Humphreys, with 39 total publications, is second only to Makela, who had 49 at the time he went up for promotion. Similarly Makela tops the list of citations at the time he went up for promotion with 560, but Humphreys' citation count is second highest. Note that in his candidate materials, Humphreys compares himself to Makela and Garrison using Publish or Perish (which is Google Scholar) for publications since 2009, and his analysis shows that there is less of a difference between him and Makela. (This difference is due to the different databases, algorithms, and dates used.) Makela also won the NSF CAREER award, but neither Garrison nor Gebre-Egziabher did. Humphreys has also not yet won the CAREER award, but he has a proposal pending at this time. In his third-year review, he was encouraged by the review

committee to write a CAREER proposal, and he only did so grudgingly since he was flush with funding and didn't feel that he could spend the funds effectively if he got it. This attitude was puzzling to the committee, and stemmed from a bit of immaturity or overconfidence on his part, but he has since realized that obtaining national awards is indeed important. The proposal he wrote this year is much improved in both the research and education plans, and I expect that he will be successful this time. Regardless, this comparison, which is based purely on productivity metrics, indicates that Humphreys' scholarly output is consistent with researchers who have been successfully promoted at peer institutions.

**Table 1. Peer comparison of scholarly output (refereed articles and proceedings from ISI)**

Name	University	Rank	PhD year	Year promoted to assoc. prof.	Career papers	Career citations	<i>h</i> -index	Career citations per paper	Papers at time of promotion	Citations at time of promotion
J.L. Garrison	Purdue	Assoc. Prof.	1997	2006	46	414	9	9	23	83
J.J. Makela	UIUC	Prof.	2003	2009	71	1136	19	16	49	560
D. Gebre-Egziabher	Minnesota	Assoc. Prof.	2002	2008	33	163	6	5	14	20
T. Humphreys	UT Austin	Asst. Prof.	2008	--	39	157	7	4	39	157

The external reviewers give us an indication of the quality of the candidate's work, his standing in his community, and the impact his work has had on the field. As noted under the BC section, while the reviewers may not all be from peer schools, their CVs show that they are all top researchers who are well qualified to review Humphreys' work. Taken as a whole the letters are very supportive and they speak to the enormous impact that Humphreys has had in the short time he has been at UT. The least useful letter is the one from Young at JPL, who says only positive things, but he clearly doesn't understand what we are looking for. We had hoped to have him assess the impact that Humphreys' work has had on NASA programs, but he did not take this approach. Overall, I agree with the BC subcommittee that there are no negative comments in these letters. The letter from Enge (Stanford) is the least effusive in tone, but does clearly outline Humphreys' achievements, approach and impact, albeit all without superlatives. To me, his favorable comparison to his own assistant professors is evidence enough that his is a positive endorsement. Several of the reviewers commented that Humphreys works in a broad range of areas, but his biggest impact has been in GPS security, where he is already an internationally recognized leader in the field. Kamalabadi (UIUC) commented, "Professor Humphreys is a widely recognized scholar with an impressive breadth of expertise and research contributions spanning the discovery and illustration of the vulnerability of GPS signals to spoofing...." He continued, "His contributions in all of these diverse areas have been at the forefront of a number of activities being pursued within the PNT community and have a profound impact on the advancement of state-of-the-art techniques." Axelrad (Purdue) comments, "His influence on the field of GPS security is quite remarkable for a faculty member at such an early stage in his career." Farrell (UC Riverside) states, "Such research, with its effective demonstration, is the type of achievement that is worth much more than the paper counts which appear in standard academic letters of reference. His research is being discussed by world leaders and is affecting national GNSS, autonomous air vehicle, and research policies." Lachapelle (Calgary), who is a

chaired professor and a fellow of ION and the Royal Society of Canada, states “He was among the very first experts to describe the threat of spoofing of GPS to the GPS civilian community. This has resulted in a rapidly increasing level of research and development activities in the area of counter-measures (anti-spoofing methods) by scores of civilian academic and industrial organizations since. His own novel research contributions in this area have garnered much attention and, as a consequence, he has become one of the few eminent researchers in the world in this area.”

To demonstrate how Humphreys’ productivity metrics compare to department norms, consider Table 2, which shows data for successful tenure cases in ASE/EM over the last 20 years. The range of the number of papers in rank is 10 to 34, with a median of 13. The range of personal share of funding (inflation adjusted) is \$1.1M to \$3.1M, with a median of \$1.6M. Humphreys’ in-rank publications and funding of 16 and \$1.8M, respectively, is right in line with the median in both categories. Of Humphreys’ 16 papers in rank, 13 of them describe work that was solely originated at UT, and 3 of them describe work from his PhD at Cornell. The number of UT-originated papers includes 11 papers that are with his students, 1 single-author paper, and one paper with Virginia Tech collaborators. He also has two more papers that are in revision after favorable reviews, all of which are with UT students. Humphreys has also graduated two PhD students (both co-supervised and so he gets credit for one), which meets our expectations. While the numbers tell one story, they do not tell it all. I do not believe there is one person listed in Table 2 who has defined a field the way that Humphreys has with GPS security.

**Table 2. Comparison current candidates with successful tenure cases in ASE/EM**

Name	UT Appt Date	Yrs in Rank when Promo Package Compiled	Yrs in Rank Elsewhere	PhD's UT	PhD's Elsewhere	MS UT	MS Elsewhere	Refereed Publications In Rank	Research Funding Actual (k\$)	Research Funding inflation adjusted (k\$)
Sirohi	9/2008	5	0	0	1	6	3	12	\$1,745	\$1,785
Landis	1/2007	0.5	5	0	1	0	1	31	\$1,300	\$1,440
Raman	9/2005	5	0	0		2.5		11	\$2,856	\$3,122
Huang	9/2002	5	0	0		3		34	\$1,094	\$1,259
Raja	1/2002	4	3	1	1	1	1	20	\$1,718	\$2,031
Ocampo	9/2000	4	0	1		4		11	\$914	\$1,154
Lightsey	9/1999	4	0	2		8		10	\$1,545	\$2,001
Akella	9/1999	5	0	1		1		16	\$1,151	\$1,452
Goldstein	1/1993	5.5	0	1		1		11	\$954	\$1,395
Clemens	1/1993	5.5	0	0.5		5		14	\$1,957	\$2,861
Humphreys	9/1/2009	5	0	1	0	1	0	16	\$1,825	\$1,824
Russell	1/16/2012	2.5	4.5	0.5	2.5	2	12	27*	\$2,201	\$2,201

Humphreys’ teaching is so demonstrably good that I think it requires little discussion. Simply put, I consider him to be our department’s best teacher. He is a dynamic lecturer who integrates

his research into his lectures in a way that engages and excites the students. His teaching statement is basically a guide for new teachers on how to teach effectively, and it is remarkable in its insight into pedagogy. The students' comments in his evaluations are as good or better than I have ever seen, and it is remarkable just how well he connects with the students. He does this while still making the courses challenging and maintaining high academic standards. The Regents teaching award is very competitive and we have had members of the Academy of Distinguished Teachers who were nominated but did not receive it. Humphreys has also won the Dean's Award for Outstanding Teaching by an Assistant Professor, and I do not think it will be long before he has won every other teaching award that UT has to offer, including membership in the Academy of Distinguished Teachers. It is not an exaggeration to say but Humphreys is a teaching juggernaut.

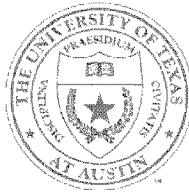
Humphreys' department service has not been extensive, although he has served on some important committees such as the department chair search committee and he currently sits on our strategic planning committee. I appointed him to the strategic planning committee, because I realized from our hallway conversations that he has great insight into trends in aerospace and emerging technologies. Overall, his level of department service is commensurate with what we expect of an assistant professor. He is, however, very visible externally, both as a consultant in regards to government policy, and by participating in service to his professional societies (ION and IEEE). The university benefits greatly from his enthusiasm for public dissemination of his expertise. Several of the reviewers commented on the high-impact of his newsworthy demonstrations, TedX talk, and congressional testimony.

In summary, Todd Humphreys meets or exceeds expectations for promotion in all areas of research, teaching and service. Although his research productivity metrics are not as high as many that have come before him, it is rare to see someone who demonstrates excellence in all aspects of his job. At this time his trajectory seems to be unbounded, and it would be a huge mistake not to promote such a unique talent. Even if he is promoted, he is a rising star who will be hard to keep at UT. I give him my very strongest support.



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Written by: Noel T. Clemens, Chair, ASE-EM Department  
September 5, 2014



COCKRELL SCHOOL OF ENGINEERING

THE UNIVERSITY OF TEXAS AT AUSTIN

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1 University Station C0803 • Austin, Texas 78712-0240 • (512) 471-6179 • Fax (512) 471-3652*

July 8, 2014

Dear Professor Noel Clemens,

I am writing this letter to endorse Assistant Professor Todd Humphrey's tenure and promotion case. I am the Director of the Wireless Networking and Communications Group (WNCG). The WNCG is a center inside the Cockrell School of Engineering (CSE) with an active Industrial Affiliate Program. We have 20 faculty members from several departments, about 150 affiliated graduate students, and have about \$5M per year in research expenditures. We have high visibility both and outside of UT Austin. Dr. Humphreys adds important expertise to our center in position / localization and security, both critical in wireless systems.

Dr. Humphreys has been a critical member of the WNCG for the past six years. During that time he has been an active member, meaning that he and his students participate in all center activities. In the duration of this letter I will comment on several ways the Dr. Humphreys has made important contributions to the WNCG.

Dr. Humphreys is the primary contact for Samsung Electronics, one of our most important industry sponsors. As primary contact, he visits them frequently, keeps them up-to-date on center activities, and ensures that the other WNCG faculty is made aware of their research interests.

Dr. Humphreys has led center funded research projects. One project was about fundamental observability in opportunistic navigation systems. Another project was on high-precision mobility trace analysis. Both projects led to important research contributions and were highly regarded by our industrial affiliates.

This past year Dr. Humphreys was the lead organizer of the Texas Wireless Summit. This is an annual even with significant industry participation and more than 100 attendees. As organizer, Dr. Humphreys selected high-profile academic and industrial speakers, coordinated panel sessions and themes, and directed outreach in advance of the conference. The conference was a great success in no small part to his efforts.

Finally, I should point out that Dr. Humphreys membership has contributed to the international visibility of the WNCG. His work on location security, in which he has demonstrated the susceptibility of GPS devices to intentional deception, brought great visibility to the Department of Aerospace Engineering & Engineering Mechanics, the WNCG, the CSE, and UT at large.

In closing, Dr. Todd Humphreys has been an active and critical member of the WNCG. We value his leadership, service, and technical contributions to the center. He has our highest recommendation for tenure and promotion.

Sincerely,

A handwritten signature in black ink, appearing to read "Robert Heath Jr."

Robert Heath Jr.

Cullen Trust Endowed Professor #6 and Director, Wireless Networking and Communications Group



COCKRELL SCHOOL OF ENGINEERING  
THE UNIVERSITY OF TEXAS AT AUSTIN

*Department of Electrical and Computer Engineering • Engineering Science Building*  
*1 University Station C0803 • Austin, Texas 78712-0240 • (512) 471-6179 • Fax (512) 471-3652*

August 4, 2014

Dear Noel

I am writing to you to highlight professor Todd Humphreys strong contributions to interdisciplinary teaching and research at the University of Texas Austin and beyond. Indeed, Todd has established a very strong bridge between our departments and is the linchpin behind several high visibility and very effective collaborative projects and efforts between the two departments.

The graduate courses that Todd teaches on statistical estimation theory and stochastic detection, estimation, and control are regularly attended by our graduate students, including my own students, and complement courses offered in our department. Todd has also participated in discussions with Pro Haris Vikalo in our department and myself on revamping and expanding our (CSE) offerings in the areas of stochastic processes and detection and estimation theory.

Todd is a very active and visible member of the Wireless and Networking Communications Group (WNCG) center. He is a regular attendee of the faculty meetings held by the center on a weekly or biweekly basis during the academic year, plays a vital role in attracting and retaining corporate sponsors of the center and is an active participant in organizing the Texas Wireless Summit, an annual event organized and hosted by the center and attended by industry, analysts and academia. In particular, Todd conceived, and was the main organizer of, the very successful Texas Wireless Summit held last year in October 2013. That Summit focused on big data and its applications in wireless communication networks and navigation and positioning. The summit was very well attended, attracting very well-known and visible international speakers from industry and academia to UT and bringing many new attendees to the event. Many of the regular participants commented that this event was one of the best they had attended in a number of years. The event was particularly noteworthy because it encouraged our Cockrell school of engineering faculty to expand into new promising areas of research and connected them with potential government and industry sponsors, as well as end-users of the technology they are likely to produce, thereby maximizing the potential societal impact of their research.

Todd has supervised PhD students from the department of electrical and computer engineering and has served or is serving on the committee of other students in the department. I myself have served on the PhD committee of one of his students and have had interactions with another PhD student who finished this past semester. This has given me an opportunity to become more familiar with Todd's research in the broad area of estimation theory and its application to navigation and localization. I will defer to our colleagues in the department of aeronautics and engineering mechanics and Todd's reference letter writers to judge the full impact of Todd's work. However, I can't help but note that the work he performed with his graduate student Kyle Wesson on the theoretical underpinnings of GPS spoofing is highly visible and exhibits a unique combination of deep mathematical understanding of the problem combined with illuminating experimental insights. His work with his PhD student Zak Kassas developed the theoretical foundations of collaborative opportunistic navigation. In particular, Todd and Zak established the feasibility exploiting ambient radio signals to continuously refine position estimates. As

you know, this work has won awards at premier navigation conferences and was highlighted in the IEEE Aerospace and Electronic Systems Magazine. Both Kyle and Zak worked closely with several professors in our department.

In my opinion, Todd epitomizes many of the characteristics that we seek in new faculty members and strive to develop in our existing faculty, including a deep commitment to interdisciplinary work and a continuing quest for new opportunities with potentially deep societal impact that lie at the intersection of a number of engineering, mathematics and computer science disciplines. .

Sincerely,

A handwritten signature in black ink, appearing to read "Ahmed H. Tewfik".

Prof. Ahmed H. Tewfik  
Cockrell Family Regents Chair in Engineering  
Chairman, Department of Electrical and Computer Engineering

Todd E. Humphreys

	<b>IONF Satellite Constellation Attitude Determination Lead</b>	<b>2001 - 2002</b>
	<b>Space Dynamics Laboratory (Logan, Utah)</b>	
	Developed magnetometer-based satellite attitude determination algorithms and a code implementation for the ION-F mission of the University Nanosatellite Program.	
	<b>MEMS Inertial Sensors Researcher</b>	<b>1999 - 2002 (summers)</b>
	<b>NASA's Jet Propulsion Laboratory – Microdevices Laboratory</b>	
	Analysis, design, and validation of meso-scale vibratory rate sensors.	
CONSULTING	Coherent Navigation, Aug. 2009 - Aug. 2012	
	U.S. Department of Homeland Security Risk Assessment: Critical infrastructure dependence on GPS, March - Sept., 2011	
MEMBERSHIPS	Member, Institute of Navigation (ION) Member, Institute of Electrical and Electronics Engineers (IEEE) Member, American Institute of Aeronautics and Astronautics (AIAA)	
PROFESSIONAL ACTIVITIES	<p><i>Editing Positions</i></p> <ul style="list-style-type: none"> <li>- Editor, IEEE Transactions on Wireless Communications, May 2014-present</li> </ul> <p><i>Institute of Navigation Positions</i></p> <ul style="list-style-type: none"> <li>- Land Representative, Institute of Navigation Governing Council, 2012-2014</li> </ul> <p><i>Conferences Organized</i></p> <ul style="list-style-type: none"> <li>- Lead organizer, 2013 Texas Wireless Summit</li> <li>- Lead organizer, University-of-Texas-hosted meeting of the world's experts on civil GPS security, September 2010</li> </ul> <p><i>Congressional Testimony</i></p> <ul style="list-style-type: none"> <li>- Invited witness, U.S. House Subcommittee on Homeland Security Oversight hearing on drone security, July 2012</li> <li>- Invited witness, U.S. House Judiciary Subcommittee on Crime, Terrorism, and Homeland Security field forum on privacy in an age of drones, October 2012</li> </ul> <p><i>Technical Program Committee</i></p> <ul style="list-style-type: none"> <li>- Track chair, Institute of Navigation GNSS+ conference, September 2013</li> </ul> <p><i>Session Chair</i></p> <ul style="list-style-type: none"> <li>- Session chair, IEEE/ION PLANS conference, May 2014: Interference and Robust Navigation</li> <li>- Session chair, Institute of Navigation International Technical Meeting, Jan. 2013: Interference and Spectrum Management</li> <li>- Session chair, Institute of Navigation GNSS conference, September 2012: Spectrum Interference</li> <li>- Session chair, IEEE/ION PLANS conference, April 2012: Receiver and Antenna Technology Session</li> <li>- Panel session chair, Institute of Navigation GNSS conference, September 2011: GNSS Security</li> <li>- Session chair, IEEE/ION PLANS conference, May 2010: Algorithms and Processing</li> </ul>	

*Invited Subject Matter Expert*

- Subject matter expert, Dept. of Homeland Security risk assessment of critical infrastructure dependence on GPS, March-September, 2011
- Subject matter expert, U.S. Patent and Trademark Office briefing on advances in GNSS technology, April 2011
- Invited presenter, National Executive Committee on Position Navigation and Timing, Advisory Board Meeting, October 2010

UNIVERSITY  
COMMITTEES;  
ADMINISTRATIVE  
ASSIGNMENTS

*Administrative Assignments*

- Director, Radionavigation Laboratory, 2009-present
- Faculty advisor, UT student chapter of AIAA, 2010-present

*University Committees*

- None

*College Committees*

- Cockrell School Honors Committee, 2011-present
- College of Engineering Faculty Committee

*Department Committees*

- ASE Department Faculty Committee
- ASE Orbits Area Faculty Committee
- ASE Graduate Studies Committee
- ECE Graduate Studies Committee

HONORS &  
AWARDS

GPS World Magazine Leadership Award, 2012

University of Texas System Regents' Outstanding Teaching Award, 2012

Cockrell School Dean's Award for Outstanding Teaching by an Assistant Professor, 2012

Best Overall Paper Award, IEEE/ION PLANS Conference, 2012 (given to my student Jahshan Bhatti)

Best Student Paper Award, IEEE/ION PLANS Conference, 2012 (given to my student Ken Pesyna)

Ralph Bolgiano, Sr. Outstanding Teaching Assistant Award, 2006

NASA Space Grant Fellowship, 2004-2005

Hertz Foundation Fellowship Finalist, 2004

AIAA Guidance, Navigation, and Control Graduate Award, 2004

2nd place, AIAA/USU Small Satellite Conference Student Paper Competition, 2002

Utah State University Presidential Fellowship, 2000-2001

REFEREED  
JOURNAL  
ARTICLES

**Articles are sorted by key topic and appear only once.**

**Navigation and Timing Security**

- J1 A. J. Kerns, D. P. Shepard, J. A. Bhatti, and T. E. Humphreys, "Unmanned aircraft capture and control via GPS spoofing," *Journal of Field Robotics*, vol. 31, no. 4, pp. 617–636, 2014 pdf
- J2 B. W. O'Hanlon, M. L. Psiaki, T. E. Humphreys, J. A. Bhatti, and D. P. Shepard, "Real-time GPS spoofing detection via correlation of encrypted signals," *Navigation, Journal of the Institute of Navigation*, vol. 60, no. 4, pp. 267–278, 2013 pdf
- J3 M. Psiaki, B. O'Hanlon, J. Bhatti, D. Shepard, and T. Humphreys, "GPS spoofing detection via dual-receiver correlation of military signals," *IEEE Transactions on Aerospace and Electronic Systems*, vol. 49, no. 4, pp. 2250–2267, 2013 pdf
- J4 D. P. Shepard, T. E. Humphreys, and A. A. Fansler, "Evaluation of the vulnerability of phasor measurement units to GPS spoofing attacks," *International Journal of Critical Infrastructure Protection*, vol. 5, no. 3-4, pp. 146–153, 2012 pdf
- J5 T. E. Humphreys, "Detection strategy for cryptographic GNSS anti-spoofing," *IEEE Transactions on Aerospace and Electronic Systems*, vol. 49, no. 2, pp. 1073–1090, 2013 pdf
- J6 K. D. Wesson, M. P. Rothlisberger, and T. E. Humphreys, "Practical cryptographic civil GPS signal authentication," *Navigation, Journal of the Institute of Navigation*, vol. 59, no. 3, pp. 177–193, 2012 pdf

**Estimation and Signal Processing**

- J7 Z. M. Kassas, A. Arapostathis, and T. E. Humphreys, "Greedy motion planning for simultaneous signal landscape mapping and receiver localization," *IEEE Journal of Selected Topics in Signal Processing*, 2014. (In preparation after favorable reviews.) pdf
- J8 Z. M. Kassas and T. E. Humphreys, "Receding horizon trajectory optimization in opportunistic navigation environments," *IEEE Transactions on Aerospace and Electronic Systems*, 2014. (To be published.) pdf
- J9 K. Pesyna, Z. Kassas, R. Heath, and T. Humphreys, "A phase-reconstruction technique for low-power centimeter-accurate mobile positioning," *IEEE Transactions on Signal Processing*, vol. 62, pp. 2595–2610, May 2014 pdf
- J10 Z. M. Kassas and T. E. Humphreys, "Observability analysis of collaborative opportunistic navigation with pseudorange measurements," *IEEE Transactions on Intelligent Transportation Systems*, vol. 15, pp. 260–273, Feb. 2014 pdf
- J11 T. E. Humphreys, M. L. Psiaki, and P. M. Kintner, Jr., "Modeling the effects of ionospheric scintillation on GPS carrier phase tracking," *IEEE Transactions on Aerospace and Electronic Systems*, vol. 46, pp. 1624–1637, Oct. 2010 pdf
- J12 T. E. Humphreys, M. L. Psiaki, B. M. Ledvina, A. P. Cerruti, and P. M. Kintner, Jr., "A data-driven testbed for evaluating GPS carrier tracking loops in ionospheric scintillation," *IEEE Transactions on Aerospace and Electronic Systems*, vol. 46, pp. 1609–1623, Oct. 2010 pdf
- J13 T. E. Humphreys, M. L. Psiaki, J. C. Hinks, B. O'Hanlon, and P. M. Kintner, Jr., "Simulating ionosphere-induced scintillation for testing GPS receiver phase tracking loops," *IEEE Journal of Selected Topics in Signal Processing*, vol. 3, pp. 707–715, Aug. 2009 pdf
- J14 T. E. Humphreys, M. Psiaki, E. Klatt, S. Powell, and P. M. Kintner, Jr., "Magnetometer-based attitude and rate estimation for a spacecraft with wire booms," *Journal of Guidance, Control, and Dynamics*, vol. 28, pp. 584–593, July–Aug. 2005 pdf

**Ionosphere and Troposphere**

- J15 H. Kim, C. Clauer, K. Deshpande, M. Lessard, A. Weatherwax, G. S. Bust, G. Crowley, and T. E. Humphreys, "Ionospheric irregularities during a substorm event: Observations of ULF pulsations and GPS scintillations," *Journal of Atmospheric and Solar-Terrestrial Physics*, vol. 114, pp. 1–8, 2014 link
- J16 K. B. Deshpande, G. S. Bust, C. R. Clauer, H. Kim, J. E. Macon, T. E. Humphreys, J. A. Bhatti, S. B. Musko, G. Crowley, and A. T. Weatherwax, "Initial GPS scintillation results from CASES receiver at South Pole, Antarctica," *Radio Science*, vol. 47, no. 5, 2012 link
- J17 T. E. Humphreys, M. C. Kelley, N. Huber, and P. M. Kintner, "The semidiurnal variation in GPS-derived zenith neutral delay," *Geophysical Research Letters*, vol. 32, no. 24, 2005 pdf

**Instrumentation**

- J18 C. R. Clauer, H. Kim, K. Deshpande, Z. Xu, D. Weimer, S. Musko, G. Crowley, C. Fish, R. Nealy, T. E. Humphreys, J. A. Bhatti, and A. J. Ridley, "Autonomous adaptive low-power instrument platform (AAL-PIP) for remote high latitude geospace data collection," *Geoscientific Instrumentation, Methods and Data Systems*, 2014. (To be published.) link
- J19 E. G. Lightsey, T. E. Humphreys, J. A. Bhatti, A. J. Joplin, B. W. OHanlon, and S. P. Powell, "Demonstration of a space capable miniature dual frequency GNSS receiver," *Navigation, Journal of the Institute of Navigation*, vol. 61, no. 1, pp. 53–64, 2014 pdf

REFEREED  
CONFERENCE  
PAPERS

- C1 T. E. Humphreys, D. P. Shepard, J. A. Bhatti, and K. D. Wesson, "A testbed for developing and evaluating GNSS signal authentication techniques," in *Proceedings of the International Symposium on Certification of GNSS Systems and Services (CERGAL)*, (Dresden, Germany), July 2014. (available at <http://radionavlab.ae.utexas.edu/testbed>)
- C2 D. P. Shepard and T. E. Humphreys, "High-precision globally-referenced position and attitude via a fusion of visual SLAM, carrier-phase-based GPS, and inertial measurements," in *Proceedings of the IEEE/ION PLANS Meeting*, May 2014 pdf
- C3 A. J. Kerns, K. D. Wesson, and T. E. Humphreys, "A blueprint for civil GPS navigation message authentication," in *Proceedings of the IEEE/ION PLANS Meeting*, May 2014 pdf
- C4 K. D. Wesson, B. L. Evans, and T. E. Humphreys, "A probabilistic framework for Global Navigation Satellite System signal timing assurance," in *Proceedings of Asilomar Conference on Signals, Systems, and Computers*, (Pacific Grove, CA), 2013 pdf
- C5 K. D. Wesson, B. L. Evans, and T. E. Humphreys, "A combined symmetric difference and power monitoring GNSS anti-spoofing technique," in *IEEE Global Conference on Signal and Information Processing*, 2013 pdf
- C6 Z. M. Kassas, J. A. Bhatti, and T. E. Humphreys, "A graphical approach to GPS software-defined receiver implementation," in *Proceedings of IEEE Global Conference on Signal and Information Processing*, December 2013 pdf
- C7 Z. Kassas and T. E. Humphreys, "The price of anarchy in active signal landscape map building," in *Proceedings of IEEE Global Conference on Signal and Information Processing*, December 2013 pdf
- C8 Z. Kassas, J. A. Bhatti, and T. E. Humphreys, "Receding horizon trajectory optimization for simultaneous signal landscape mapping and receiver localization," in *Proceedings of the ION GNSS+ Meeting*, September 2013 pdf

- C9 K. M. Pesyna Jr., R. W. Heath Jr., and T. E. Humphreys, "Precision limits of low-energy GNSS receivers," in *Proceedings of the ION GNSS+ Meeting*, (Nashville, Tennessee), Institute of Navigation, 2013 pdf  
**Best presentation award in session of 8 papers.**
- C10 Z. M. Kassas and T. E. Humphreys, "Motion planning for optimal information gathering in opportunistic navigation systems," in *AIAA Guidance, Navigation, and Control Conference (GNC'13)*, (Boston, MA), pp. 4551–4565, Aug. 2013 pdf
- C11 K. D. Wesson, T. E. Humphreys, and B. L. Evans, "Position paper: Secure time transfer for CPS," in *NSF/NSA National Workshop on The New Clockwork for Time-Critical Systems*, 2012 pdf
- C12 D. P. Shepard, K. M. Pesyna, and T. Humphreys, "Precise augmented reality enabled by carrier-phase differential GPS," in *Proceedings of the ION GNSS Meeting*, (Nashville, Tennessee), Institute of Navigation, 2012 pdf
- C13 D. P. Shepard, J. A. Bhatti, T. E. Humphreys, and A. A. Fansler, "Evaluation of smart grid and civilian UAV vulnerability to GPS spoofing attacks," in *Proceedings of the ION GNSS Meeting*, 2012 pdf
- C14 Z. M. Kassas and T. E. Humphreys, "Observability and estimability of collaborative opportunistic navigation with pseudorange measurements," in *Proceedings of the ION GNSS Meeting*, (Nashville, Tennessee), Institute of Navigation, 2012 pdf
- C15 T. E. Humphreys, J. A. Bhatti, D. P. Shepard, and K. D. Wesson, "The Texas Spoofing Test Battery: Toward a standard for evaluating GNSS signal authentication techniques," in *Proceedings of the ION GNSS Meeting*, 2012. <http://radionavlab.ae.utexas.edu/texbat>
- C16 Z. M. Kassas and T. E. Humphreys, "Observability analysis of opportunistic navigation with pseudorange measurements," in *Proceedings of AIAA Guidance, Navigation, and Control Conference*, Aug. 2012 pdf
- C17 J. A. Bhatti, T. E. Humphreys, and B. M. Ledvina, "Development and demonstration of a TDOA-based GNSS interference signal localization system," in *Proceedings of the IEEE/ION PLANS Meeting*, pp. 1209–1220, April 2012 pdf  
**Conference overall best paper award.**
- C18 K. M. Pesyna, Z. M. Kassas, and T. E. Humphreys, "Constructing a continuous phase time history from TDMA signals for opportunistic navigation," in *Proceedings of the IEEE/ION PLANS Meeting*, pp. 1209–1220, April 2012 pdf  
**Conference best student paper award.**
- C19 D. Shepard, T. E. Humphreys, and A. Fansler, "Evaluation of the vulnerability of Phasor Measurement Units to GPS spoofing," in *Sixth Annual IFIP WG 11.10 International Conference on Critical Infrastructure Protection*, (Washington, DC), Mar. 2012 pdf
- C20 A. J. Joplin, E. G. Lightsey, and T. E. Humphreys, "Development and testing of a miniaturized, dual-frequency GPS receiver for space applications," in *Proceedings of the ION International Technical Meeting*, (Long Beach, CA), Jan. 2012 pdf
- C21 K. D. Wesson, M. P. Rothlisberger, and T. E. Humphreys, "A proposed navigation message authentication implementation for civil GPS anti-spoofing," in *Proceedings of the ION GNSS Meeting*, (Portland, Oregon), Institute of Navigation, 2011 pdf
- C22 D. Shepard and T. E. Humphreys, "Characterization of receiver response to a spoofing attack," in *Proceedings of the ION GNSS Meeting*, (Portland, Oregon), Institute of Navigation, 2011 pdf

- C23 R. Mitch, R. Dougherty, M. Psiaki, S. Powell, B. O'Hanlon, J. Bhatti, and T. Humphreys, "Signal characteristics of civil GPS jammers," in *Proceedings of the ION GNSS Meeting*, 2011 pdf  
**Best presentation award in session of 8 papers.**
- C24 M. L. Psiaki, B. W. O'Hanlon, J. A. Bhatti, and T. E. Humphreys, "Civilian GPS spoofing detection based on dual-receiver correlation of military signals," in *Proceedings of the ION GNSS Meeting*, (Portland, Oregon), Institute of Navigation, 2011 pdf
- C25 G. Crowley, G. S. Bust, A. Reynolds, I. Azeem, R. Wilder, B. W. O'Hanlon, M. L. Psiaki, S. Powell, T. E. Humphreys, and J. A. Bhatti, "CASES: A novel low-cost ground-based dual-frequency GPS software receiver and space weather monitor," in *Proceedings of the ION GNSS Meeting*, (Portland, Oregon), Institute of Navigation, 2011 pdf
- C26 B. O'Hanlon, M. Psiaki, S. Powell, J. Bhatti, T. E. Humphreys, G. Crowley, and G. Bust, "CASES: A smart, compact GPS software receiver for space weather monitoring," in *Proceedings of the ION GNSS Meeting*, (Portland, Oregon), pp. 2745–2753, Institute of Navigation, 2011 pdf
- C27 K. D. Wesson, D. P. Shepard, J. A. Bhatti, and T. E. Humphreys, "An evaluation of the vestigial signal defense for civil GPS anti-spoofing," in *Proceedings of the ION GNSS Meeting*, (Portland, OR), 2011 pdf  
**Best presentation award in session of 8 papers.**
- C28 K. Pesyna, Z. Kassas, J. Bhatti, and T. E. Humphreys, "Tightly-coupled opportunistic navigation for deep urban and indoor positioning," in *Proceedings of the ION GNSS Meeting*, (Portland, Oregon), Institute of Navigation, 2011 pdf
- C29 K. M. Pesyna, Jr., K. D. Wesson, R. W. Heath, Jr., and T. E. Humphreys, "Extending the reach of GPS-assisted femtocell synchronization and localization through tightly-coupled opportunistic navigation," in *IEEE GLOBECOM Workshop*, 2011 pdf
- C30 B. O'Hanlon, J. Bhatti, T. E. Humphreys, and M. Psiaki, "Real-time spoofing detection in a narrow-band civil GPS receiver," in *Proceedings of the ION GNSS Meeting*, (Portland, Oregon), Institute of Navigation, 2010
- C31 T. E. Humphreys, J. Bhatti, and B. Ledvina, "The GPS Assimilator: a method for upgrading existing GPS user equipment to improve accuracy, robustness, and resistance to spoofing," in *Proceedings of the ION GNSS Meeting*, (Portland, Oregon), Institute of Navigation, 2010 pdf
- C32 K. Wesson, K. Pesyna, J. Bhatti, and T. E. Humphreys, "Opportunistic frequency stability transfer for extending the coherence time of GNSS receiver clocks," in *Proceedings of the ION GNSS Meeting*, (Portland, Oregon), Institute of Navigation, 2010 pdf
- C33 T. E. Humphreys, J. Bhatti, T. Pany, B. Ledvina, and B. O'Hanlon, "Exploiting multi-core technology in software-defined GNSS receivers," in *Proceedings of the ION GNSS Meeting*, (Savannah, GA), pp. 326–338, Institute of Navigation, 2009 pdf
- C34 B. W. O'Hanlon, M. L. Psiaki, P. M. Kintner, Jr., and T. E. Humphreys, "Development and field testing of a DSP-based dual-frequency software GPS receiver," in *Proceedings of the ION GNSS Meeting*, (Savannah, GA), Institute of Navigation, 2009 pdf
- C35 T. E. Humphreys, B. M. Ledvina, M. L. Psiaki, B. W. O'Hanlon, and P. M. Kintner, Jr., "Assessing the spoofing threat: Development of a portable GPS civilian spoofer," in *Proceedings of the ION GNSS Meeting*, (Savannah, GA), Institute of Navigation, 2008 pdf
- C36 J. C. Hinks, T. E. Humphreys, B. O'Hanlon, M. L. Psiaki, and P. M. Kintner, Jr., "Evaluating GPS receiver robustness to ionospheric scintillation," in *Proceedings of the ION GNSS Meeting*, (Savannah, GA), Institute of Navigation, 2008 pdf  
**Best presentation award in session of 8 papers.**

- C37 S. Mohiuddin, T. E. Humphreys, and M. L. Psiaki, "A technique for determining the carrier phase differences between independent GPS receivers during scintillation," *Proceedings of the ION GNSS Meeting*, 2007 pdf  
**Best presentation award in session of 8 papers.**
- C38 M. L. Psiaki, T. E. Humphreys, S. Mohiuddin, S. P. Powell, A. P. Cerruti, and P. M. Kintner, Jr., "Searching for Galileo," in *Proceedings of the ION GNSS Meeting*, (Fort Worth, TX), Institute of Navigation, 2006 pdf  
**Best presentation award in session of 8 papers.**
- C39 T. E. Humphreys, B. M. Ledvina, M. L. Psiaki, and P. M. Kintner, Jr., "GNSS receiver implementation on a DSP: Status, challenges, and prospects," in *Proceedings of the ION GNSS Meeting*, (Fort Worth, TX), pp. 2370–2382, Institute of Navigation, 2006 pdf  
**Best presentation award in session of 8 papers.**
- C40 T. E. Humphreys, M. L. Psiaki, B. M. Ledvina, and P. M. Kintner, Jr., "GPS carrier tracking loop performance in the presence of ionospheric scintillations," in *Proceedings of the ION GNSS Meeting*, (Long Beach, CA), Institute of Navigation, Sept. 2005 pdf  
**Best presentation award in session of 8 papers.**
- C41 T. E. Humphreys, B. M. Ledvina, M. L. Psiaki, and P. M. Kintner, "Analysis of ionospheric scintillations using wideband GPS L1 C/A signal data," in *Proceedings of the ION GNSS Meeting*, (Long Beach, California), pp. 399–407, Institute of Navigation, 2004 pdf
- C42 T. E. Humphreys, M. Kelley, and P. M. Kintner, Jr., "GPS-based measurement of atmospheric tides," in *Proceedings of the ION GNSS Meeting*, (Long Beach, California), pp. 864–880, Institute of Navigation, 2004
- C43 T. E. Humphreys, "Attitude determination for small satellites with modest pointing constraints," in *Proc. 2002 AIAA/USU Small Satellite Conference*, (Logan, Utah), 2002

#### OTHER MAJOR PUBLICATIONS

- M1 K. D. Wesson and T. E. Humphreys, "Hacking drones," *Scientific American*, vol. 309, no. 5, pp. 54–59, 2013
- M2 D. P. Shepard, J. A. Bhatti, and T. E. Humphreys, "Drone hack: Spoofing attack demonstration on a civilian unmanned aerial vehicle," *GPS World*, Aug. 2012
- M3 D. P. Shepard, T. E. Humphreys, and A. A. Fansler, "Going up against time: The power grid's vulnerability to GPS spoofing attacks," *GPS World*, Aug. 2012
- M4 T. E. Humphreys, "Statement on privacy issues related to the domestic use of unmanned aerial vehicles." <http://radionavlab.ae.utexas.edu/images/stories/files/papers/statementOctober.pdf>, Oct. 2012
- M5 T. E. Humphreys, "Statement on the vulnerability of civil unmanned aerial vehicles and other systems to civil GPS spoofing." <http://homeland.house.gov/sites/homeland.house.gov/files/Testimony-Humphreys.pdf>, July 2012
- M6 T. E. Humphreys, "The GPS dot and its discontents: Privacy vs. GNSS integrity," *Inside GNSS*, vol. 7, Mar./Apr. 2012
- M7 R. Mitch, R. Dougherty, M. Psiaki, S. Powell, B. O'Hanlon, J. Bhatti, and T. E. Humphreys, "Know your enemy: Signal characteristics of civil GPS jammers," *Inside GNSS*, Jan. 2012
- M8 K. D. Wesson, D. P. Shepard, and T. E. Humphreys, "Straight talk on anti-spoofing: Securing the future of PNT," *GPS World*, Jan. 2012
- M9 T. E. Humphreys, J. Bhatti, and B. M. Ledvina, "The GPS Assimilator: Upgrading receivers via benign spoofing," *Inside GNSS*, vol. 5, pp. 50–58, June 2010
- M10 P. M. Kintner, Jr., T. E. Humphreys, and J. Hinks, "GNSS and ionospheric scintillation: How to survive the next solar maximum," *Inside GNSS*, vol. 4, pp. 22–30, July 2009

- M11 P. Y. Montgomery, T. E. Humphreys, and B. M. Ledvina, "A multi-antenna defense: Receiver-autonomous GPS spoofing detection," *Inside GNSS*, vol. 4, pp. 40–46, April 2009
- M12 T. E. Humphreys, B. M. Ledvina, M. L. Psiaki, B. W. O'Hanlon, and P. M. Kintner, Jr., "Assessing the spoofing threat," *GPS World*, vol. 20, pp. 28–38, Jan. 2009
- M13 T. E. Humphreys, *Modeling Ionospheric Scintillation and its Effects on GPS Carrier Tracking Loops and Two Other Applications of Modeling and Estimation*. PhD thesis, Cornell University, Ithaca, New York, 2008
- M14 T. E. Humphreys, L. Young, and T. Pany, "Considerations for future IGS receivers," in *Position Paper of the 2008 IGS Workshop*, 2008. <http://www.ngs.noaa.gov/IGSWorkshop2008/docs/recDev-positionpaper.pdf>
- M15 M. L. Psiaki, T. E. Humphreys, S. Mohiuddin, S. P. Powell, A. P. Cerruti, and J. Paul M. Kintner, "Searching for Galileo: Reception and analysis of signals from GIOVE-A," *GPS World*, vol. 17, pp. 66–72, June 2006
- M16 T. E. Humphreys, "Attitude determination for small satellites with modest pointing constraints," Master's thesis, Utah State University, Logan, Utah, 2003

BOOK CHAPTERS    T. E. Humphreys, *The GNSS Handbook*, ch. Interference. Springer, 2014. (in preparation)

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| ORAL<br>PRESENTATIONS | <ul style="list-style-type: none"> <li>O1 April 15, 2014, "Secure Perception for Autonomous Systems," (invited) University of Texas Student Engineering Council Symposium, Austin, TX.</li> <li>O2 March 13, 2014, "Secure Perception for Autonomous Systems," (invited) University of Illinois at Urbana-Champaign, Urbana, IL. Slides available at <a href="http://tinyurl.com/onksode">http://tinyurl.com/onksode</a>.</li> <li>O3 March 6, 2014, "Secure Perception for Autonomous Systems, (invited keynote presentation) Cornell Sibley Graduate Research Symposium, Ithaca, NY.</li> <li>O4 March 7, 2014, "Location Deception," (invited) SXSW Interactive, Austin, TX. Audio available at <a href="https://soundcloud.com/officialsxsw/location-deception-yacht-vs">https://soundcloud.com/officialsxsw/location-deception-yacht-vs</a>.</li> <li>O5 November 14, 2013, "Secure PNT for Autonomous Systems," (invited) Stanford PNT Symposium, Stanford University, Stanford, CA.</li> <li>O6 September 26, 2013, "Maritime Navigation Security," (invited) International Hydrographic Organisation &amp; Professional Yachters Association Sea Changes Seminar, Monaco.</li> <li>O7 March 8, 2013, "Extreme GPS," (invited) SXSW Interactive, Austin, TX. Audio available at <a href="http://schedule.sxsw.com/2013/events/event_IAP6353">http://schedule.sxsw.com/2013/events/event_IAP6353</a>. Slides available at <a href="http://tinyurl.com/qbolhgvy">http://tinyurl.com/qbolhgvy</a>.</li> <li>O8 March 6, 2013, "Drones in the Classroom," (invited) SXSW Edu, Austin, TX.</li> <li>O9 February 13, 2013, "Secure Navigation and Timing," (invited keynote) Royal Institute of Navigation Interference Conference, Teddington, UK.</li> <li>O10 February 12, 2013, "UAV Integration: Privacy and Security Hurdles," Royal Institute of Navigation UAV Conference, Teddington, UK.</li> <li>O11 February 7, 2013, "GPS Vulnerabilities and Implications for Telecom," (invited) international webinar. Slides available at <a href="http://tinyurl.com/k9gmxw">http://tinyurl.com/k9gmxw</a>.</li> <li>O12 December 5, 2012, "Navigation and Timing Security," (invited) U.S. Air Force GPS Directorate, Los Angeles, CA.</li> <li>O13 November 15, 2012, "Future Directions in GNSS Research," (invited) international GPS World webinar. Slides available at <a href="http://tinyurl.com/mcskesm">http://tinyurl.com/mcskesm</a>.</li> </ul> |
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- O14 October 25, 2012, "Privacy Issues Related to the Domestic Use of Unmanned Aerial Vehicles," (invited) statement to the U.S. House Judiciary Subcommittee on Crime, Terrorism, and Homeland Security field forum, Houston, TX. Statement available at <http://tinyurl.com/pvuzpzv>.
- O15 October 17, 2012, "Secure Civil Navigation and Timing," (invited) Sandia National Laboratory, Albuquerque, NM.
- O16 September 17, 2012, "Receiver Certification for Hardening Against Spoofing," (invited) Civil GPS Service Interface Committee, Nashville, TN.
- O17 September 10, 2012, "Secure Civil Navigation and Timing," (invited) Aerospace Corporation research seminar, virtual from Austin, TX.
- O18 July 20, 2012, "Secure Civil Navigation and Timing," (invited) MITRE corporation and government customers, McLean, VA.
- O19 July 19, 2012, "Radionavigation Robustness and Security," (invited) Office of Naval Research, Arlington, VA.
- O20 July 19, 2012, "The vulnerability of civil unmanned aerial vehicles and other systems to civil GPS spoofing," (invited) U.S. House Subcommittee on Homeland Security Oversight hearing on drone security, Washington, DC. Video available at <http://www.c-span.org/video/?307143-1/domestic-drone-oversight>. Statement available at <http://tinyurl.com/lka3fkp>.
- O21 June 6, 2012, "Privacy vs. GPS Integrity," (invited) Civil GPS Service Interface Committee (CGSIC) Meeting, Austin, TX.
- O22 February 22, 2012, "PVT Security: Privacy and Trustworthiness," (invited keynote) Royal Institute of Navigation Conference on GNSS Vulnerability: Present Dangers, Future Threats 2012, Teddington, UK.
- O23 February 11, 2012, "How to fool a GPS," (invited) TEDxAustin, Austin, TX. Video available at [http://www.ted.com/talks/todd\\_humphreys\\_how\\_to\\_fool\\_a\\_gps](http://www.ted.com/talks/todd_humphreys_how_to_fool_a_gps).
- O24 December 2, 2011, "Radionavigation Robustness and Security," (invited) Draper Laboratory, Cambridge, MA.
- O25 December 1, 2011, "Cubesat-Sized Radio Occultation Experiments," (invited) Massachusetts Institute of Technology Aeronautics and Astronautics Department, Cambridge, MA.
- O26 April 4, 2011, "State of the art and future trends in radionavigation," (invited) US Patent and Trademark Office, virtual presentation from Austin, TX. Slides available at <http://tinyurl.com/1bn998y>.
- O27 March 10, 2011, "Briefing to DHS and DOD on GPS Security and Integrity," (invited), Austin, TX. Slides available at <http://tinyurl.com/m9h35tt>
- O28 October 4, 2010, "Spoofing the timing signal: What else is vulnerable?" (invited) National Executive Committee on Position Navigation and Timing, Advisory Board Meeting, Washington, DC.
- O29 June 25, 2010, "Advances in GNSS Equipment," (invited) 2010 IGS Workshop, International GNSS Service, Newcastle upon Tyne, UK.
- O30 January 12, 2010, "Riding out the rough spots: Scintillation-robust GNSS carrier tracking," (invited) 2010 Air Force Orion Conference, Dayton, OH.
- O31 March, 2009, "Assessing the GPS spoofing threat," (invited) Cornell University, Ithaca, NY.
- O32 June 5, 2008, "Considerations for future IGS receivers," (invited) 2008 IGS Workshop, International GNSS Service, Miami Beach, FL.

O33 March, 2006, "The semidiurnal variation in GPS-derived zenith neutral delay," (invited) 2006 IGS Workshop, Darmstadt, Germany.

PATENTS P1 K. J. Hayworth, K. V. Shcheglov, T. E. Humphreys, and A. D. Challoner, "Electrostatic spring softening in redundant degree of freedom resonators," Nov. 30 2004. US Patent 6,823,734

P2 W. J. Bencze, C. E. Cohen, B. T. Galusha, T. E. Humphreys, B. M. Ledvina, and M. L. Psiaki, "Practical method for upgrading existing GNSS user equipment with tightly integrated nav-com capability," July 12 2011. US Patent 7,978,130

P3 D. Shepard, T. E. Humphreys, K. Pesyna, and J. Bhatti, "A system and method for using global navigation satellite system (GNSS) navigation and visual navigation to recover absolute position and attitude without any prior association of visual features with known coordinates," Feb. 2014. US Patent filed on Feb., 3, 2014

SOFTWARE S1 T. E. Humphreys, J. A. Bhatti, and D. P. Shepard, "General radionavigation interfusion device (GRID) software suite (GSS)," 2010. UTA Tech ID 5900 HUM

S2 T. E. Humphreys, J. A. Bhatti, and D. P. Shepard, "Radionavigation security testbed software," 2012. UTA Tech ID 6199 HUM

RESEARCH TOPICS Optimal estimation and detection, navigation and timing security, cyber-physical systems security, Global Navigation Satellite Systems (GNSS) signal processing, GNSS-based study of the ionosphere and neutral atmosphere, GNSS integrity and security, software-defined radio.

	External	Internal	Total
Career total:	\$4,382,640	\$185,000	\$4,567,640
Humphreys share career:	\$1,714,640	\$110,000	\$1,824,640
In-rank total:	\$4,382,640	\$185,000	\$4,567,640
Humphreys share in rank:	\$1,714,640	\$110,000	\$1,824,640

#### *Individual Projects*

- \$100,000, Jan. 2014–Jan. 2015, "Precise positioning for mobile devices," Samsung Research America.
- \$120,000, June 2013–June 2015, "Strengthening GPS Receiver Resistance to Deceptive Civil Signals," U.S. Air Force GPS Directorate, NAVSEA/NGA.
- \$23,000, June 2013–June 2014, "Communication and Location Research," gift funding from the UT Wireless Networking and Communications Group.
- \$150,000, June 2013–April 2014, "GPS Timing Phase II Proof of Concept," U.S. Defense Threat Reduction Agency via Northrop Grumman Corp.
- \$225,016, April 2013–April 2015, "Emitter locator (EMLOC) system for emitter detection and localization—Phase II, U.S. Navy via Coherent Navigation.
- \$36,000, Sept. 2012–Dec. 2013, "Cooperative Opportunistic Navigation Research," gift funding from NSF WiCAT Center, UT Wireless Networking and Communications Group.
- \$75,000, Sept. 2012–Aug. 2013, "Research into UAV Navigation System Vulnerability to Spoofing Attacks," Harris Corp.
- \$20,000, June 2012–June 2013, "Communication and Location Research," gift funding from the UT Wireless Networking and Communications Group.

- \$40,083, July 2012–Nov. 2012, “GPS Vulnerability Simulation Support,” Sandia National Laboratory.
- \$23,000, June 2011–June 2012, “Communication and Location Research,” gift funding from the UT Wireless Networking and Communications Group.
- \$34,000, Aug. 2011–Mar. 2012, “Emitter locator (EMLOC) system for emitter detection and localization—Phase I,” U.S. Navy via Coherent Navigation.
- \$65,050, Nov. 2011–Jan. 2012, “Cyber Critical Infrastructure Protection GPS Timing Proof of Concept,” Northrop Grumman Corp.
- \$69,000, Nov. 2010–Jan. 2011, “FOTON sensor development,” Lockheed Martin Corp.
- \$120,000, Sept. 2010–Jan. 2012, “IGPS technology concept demonstration time and frequency stability transfer model,” The Boeing Company.
- \$8,000, June 2010–June 2011, “Communication and Location Research,” gift funding from the UT Wireless Networking and Communications Group.
- \$240,000<sup>1</sup>, Sept. 2010–July 2012, “Investigation into GPS jamming detection and localization techniques,” Coherent Navigation, Inc.
- \$120,000, Jan. 2010–Dec. 2011, “CASES Adaptations for Antarctic Deployment,” National Science Foundation via ASTRA Space LLC.
- \$224,491, June 2009–March 2011, “Connected Autonomous Space Environment Sensors (CASES),” U.S. Air Force Office of Sponsored Research via ASTRA Space LLC.

*Joint Projects*

- \$2,800,000 (total); \$132,000 (Humphreys), Sept. 2013–Sept. 2017, “Data-Supported Transportation Operations and Planning (D-STOP),” U.S. Department of Transportation. Principal Investigator: Chandra Bhat, UT Center for Transportation Research. Co-Investigators: A total of 8 faculty from the UT Wireless Communications and Networking Group and the UT Center for Transportation Research.
- \$75,000 (total); \$0 (Humphreys), May 2014–May 2015, “Development of Transformative Tracking and Mapping Instrumentation for Tracking, Mapping and Identifying Camouflage and Navigation Strategies in Dynamic, Complex Environments,” UT College of Natural Sciences Catalyst Grant Competition. Principal Investigator: Molly Cummings, Integrative Biology.

CURRENT  
GRADUATE  
STUDENTS

*Ph.D.-track Students Admitted To Candidacy*

- Jahshan Bhatti
- Ken Pesyna (Primary supervisor: Humphreys; Co-supervisor: Robert Heath (ECE))
- Daniel Shepard

*Ph.D.-track Students not yet Admitted To Candidacy*

- Andrew Kerns
- Nathan Green

GRADUATE  
SUPERVISION  
COMPLETED

*Ph.D. Dissertations*

- Z. M. Kassas, *Analysis and Synthesis of Collaborative Opportunistic Navigation Systems*, PhD thesis, The University of Texas at Austin, May 2014. Current position: Assistant professor, Department of Electrical Engineering, University of California, Riverside. Primary supervisor: Humphreys; Co-supervisor: Aristotle Arapostathis (ECE).

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<sup>1</sup>Award was reduced to less than this amount before the end of the project period.

- K. Wesson, *Secure Navigation And Timing Without Local Storage Of Secret Keys*. PhD thesis, The University of Texas at Austin, May 2014. Current position: Senior Researcher, Zeta Associates. Primary supervisor: Humphreys; Co-supervisor: Brian Evans (ECE).

*M.S. Reports and Theses*

- A. J. Joplin, "Development and testing of a miniaturized, dual-frequency, software-defined GPS receiver for space applications," Master's thesis, The University of Texas at Austin, Dec. 2011. Current position: Research staff, Applied Research Laboratories. Primary supervisor: Glenn Lightsey; Co-supervisor: Humphreys.
- M. W. Bright, "GPS L2C signal survey and the development of the emergent MATLAB L2C (EMAL2) receiver," master's report, The University of Texas at Austin, Aug. 2012. Current position: Technical staff, John Deere Intelligent Solutions Group. Primary supervisor: Humphreys; Co-supervisor: Bob Schutz.

OTHER RESEARCH *Ph.D. Defense Committees*

SUPERVISION Kien Trung Truong, Kumar Appaiah, Thomas Novlan, Vidur Bhargava, Drew Jones, Jaegan Ko, Jing Lin, Chao Jia, Yezhou Wang, Noah Smith

*Ph.D. Qualifying Committees*

Kien Trung Truong, Kumar Appaiah, Thomas Novlan, Vidur Bhargava, Ehab Hussein Hassan, Yousof Mortazavi, Drew Jones, Jaegan Ko, Jing Lin, Chao Jia, Yezhou Wang

*M.S. Report Committees*

Constance McDaniel Wyman

*Undergraduate Honors Projects*

Daniel Shepard, Shubhodeep Mukherji

## LIST OF CO-AUTHORED WORKS AND EXPLANATION

TODD HUMPHREYS

### REFEREED JOURNAL ARTICLES

TABLE 1. Summary Statistics for Refereed Journal Articles Published or Accepted as of September 12, 2014

Set Description	Number of Articles
Career total	18
In rank	16
Conceived and written in rank	13
In rank and corresponding author is Humphreys or Humphreys's student	10

**Articles are sorted by key topic and appear only once.**

#### Navigation and Timing Security

- J1 A. J. Kerns, D. P. Shepard, J. A. Bhatti, and T. E. Humphreys, “Unmanned aircraft capture and control via GPS spoofing,” *Journal of Field Robotics*, vol. 31, no. 4, pp. 617–636, 2014  
 • **Authors:** Kerns, Shepard, and Bhatti are UT graduate students supervised by Humphreys.
- J2 B. W. O’Hanlon, M. L. Psiaki, T. E. Humphreys, J. A. Bhatti, and D. P. Shepard, “Real-time GPS spoofing detection via correlation of encrypted signals,” *Navigation, Journal of the Institute of Navigation*, vol. 60, no. 4, pp. 267–278, 2013  
 • **Authors:** O’Hanlon is Cornell graduate student, Psiaki is professor at Cornell (and former Humphreys supervisor), Bhatti and Shepard are UT graduate students supervised by Humphreys.  
 • **Contributions:** Psiaki, O’Hanlon, and Bhatti conceived the project. O’Hanlon, Bhatti, and Shepard conducted the analysis and experiments with guidance from Humphreys. O’Hanlon wrote the paper with input from Psiaki and Humphreys.
- J3 M. Psiaki, B. O’Hanlon, J. Bhatti, D. Shepard, and T. Humphreys, “GPS spoofing detection via dual-receiver correlation of military signals,” *IEEE Transactions on Aerospace and Electronic Systems*, vol. 49, no. 4, pp. 2250–2267, 2013  
 • **Authors:** Psiaki is Professor at Cornell (and former Humphreys supervisor), O’Hanlon is Cornell graduate student, Bhatti and Shepard are UT graduate students supervised by Humphreys.

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*Date:* September 12, 2014.

- **Contributions:** Psiaki conceived the project with input from Humphreys. O'Hanlon, Bhatti, Shepard, and Psiaki conducted the analysis and experiments with input from Humphreys. Psiaki wrote the paper with input from Humphreys.
- J4 D. P. Shepard, T. E. Humphreys, and A. A. Fansler, "Evaluation of the vulnerability of phasor measurement units to GPS spoofing attacks," *International Journal of Critical Infrastructure Protection*, vol. 5, no. 3-4, pp. 146–153, 2012
- **Authors:** Shepard is UT graduate student supervised by Humphreys, Fansler is collaborator from Northrop Grumman Corp.
  - **Contributions:** Humphreys and Shepard conceived the project. Shepard, Humphreys, and Fansler conducted the analysis and experiments. Shepard and Humphreys wrote the paper with input from Fansler.
- J5 T. E. Humphreys, "Detection strategy for cryptographic GNSS anti-spoofing," *IEEE Transactions on Aerospace and Electronic Systems*, vol. 49, no. 2, pp. 1073–1090, 2013
- **Contributions:** Humphreys conceived the project, conducted the analysis and experiments, and wrote the paper.
- J6 K. D. Wesson, M. P. Rothlisberger, and T. E. Humphreys, "Practical cryptographic civil GPS signal authentication," *Navigation, Journal of the Institute of Navigation*, vol. 59, no. 3, pp. 177–193, 2012
- **Authors:** Wesson and Rothlisberger are UT graduate students supervised by Humphreys.

## Estimation and Signal Processing

- J7 Z. M. Kassas, A. Arapostathis, and T. E. Humphreys, "Greedy motion planning for simultaneous signal landscape mapping and receiver localization," *IEEE Journal of Selected Topics in Signal Processing*, 2014. (In preparation after favorable reviews.)
- **Authors:** Kassas is UT graduate student supervised by Humphreys. Arapostathis is UT professor and co-supervisor of Kassas.
  - **Contributions:** Humphreys and Kassas conceived the project. Kassas conducted the analysis and experiments with input from Humphreys. Kassas wrote the paper with input from Humphreys and Arapostathis.
- J8 Z. M. Kassas and T. E. Humphreys, "Receding horizon trajectory optimization in opportunistic navigation environments," *IEEE Transactions on Aerospace and Electronic Systems*, 2014. (To be published.)
- **Authors:** Kassas is UT graduate student supervised by Humphreys.
- J9 K. Pesyna, Z. Kassas, R. Heath, and T. Humphreys, "A phase-reconstruction technique for low-power centimeter-accurate mobile positioning," *IEEE Transactions on Signal Processing*, vol. 62, pp. 2595–2610, May 2014
- **Authors:** Pesyna and Kassas are UT graduate students supervised by Humphreys. Heath is UT professor and co-supervisor of Pesyna.
  - **Contributions:** Humphreys and Pesyna conceived the project and did the experiments and analysis with input from Kassas. Pesyna and Humphreys wrote the paper with input from Heath.
- J10 Z. M. Kassas and T. E. Humphreys, "Observability analysis of collaborative opportunistic navigation with pseudorange measurements," *IEEE Transactions on Intelligent Transportation Systems*, vol. 15, pp. 260–273, Feb. 2014

- **Authors:** Kassas is UT graduate student supervised by Humphreys.
- J11 T. E. Humphreys, M. L. Psiaki, and P. M. Kintner, Jr., “Modeling the effects of ionospheric scintillation on GPS carrier phase tracking,” *IEEE Transactions on Aerospace and Electronic Systems*, vol. 46, pp. 1624–1637, Oct. 2010
- **Authors:** Psiaki and Kintner are Cornell professors (and former Humphreys supervisors).
  - **Contributions:** Humphreys and Psiaki conceived the project. Humphreys conducted the analysis and experiments with input from Psiaki and Kintner. Humphreys wrote the paper with input from Psiaki.
- J12 T. E. Humphreys, M. L. Psiaki, B. M. Ledvina, A. P. Cerruti, and P. M. Kintner, Jr., “A data-driven testbed for evaluating GPS carrier tracking loops in ionospheric scintillation,” *IEEE Transactions on Aerospace and Electronic Systems*, vol. 46, pp. 1609–1623, Oct. 2010
- **Authors:** Psiaki and Kintner are Cornell professors (and former Humphreys supervisors). Ledvina and Cerruti are Cornell graduate students.
  - **Contributions:** Humphreys and Psiaki conceived the project. Humphreys conducted the analysis and experiments with input from Psiaki and Kintner. Ledvina and Cerruti gathered data. Humphreys wrote the paper with input from Psiaki and Kintner.
- J13 T. E. Humphreys, M. L. Psiaki, J. C. Hinks, B. O’Hanlon, and P. M. Kintner, Jr., “Simulating ionosphere-induced scintillation for testing GPS receiver phase tracking loops,” *IEEE Journal of Selected Topics in Signal Processing*, vol. 3, pp. 707–715, Aug. 2009
- **Authors:** Psiaki and Kintner are Cornell professors (and former Humphreys supervisors). O’Hanlon and Hinks are graduate students at Cornell.
  - **Contributions:** Humphreys and Psiaki conceived the project. Humphreys conducted the analysis and experiments with input from Psiaki and Kintner. Humphreys wrote the paper with input from Psiaki, Kintner, O’Hanlon, and Hinks.
- J14 T. E. Humphreys, M. Psiaki, E. Klatt, S. Powell, and P. M. Kintner, Jr., “Magnetometer-based attitude and rate estimation for a spacecraft with wire booms,” *Journal of Guidance, Control, and Dynamics*, vol. 28, pp. 584–593, July–Aug. 2005
- **Authors:** Psiaki and Kintner are Cornell professors (and former Humphreys supervisors). Klatt is Cornell graduate student. Powell is senior technical staff at Cornell.
  - **Contributions:** Psiaki conceived the project. Psiaki, Powell, and Kintner conducted the experiment. Humphreys performed the analysis with input from Psiaki and Klatt. Humphreys wrote the paper with input from Psiaki.

### **Ionosphere and Troposphere**

- J15 H. Kim, C. Clauer, K. Deshpande, M. Lessard, A. Weatherwax, G. S. Bust, G. Crowley, and T. E. Humphreys, “Ionospheric irregularities during a substorm event: Observations of ULF pulsations and GPS scintillations,” *Journal of Atmospheric and Solar-Terrestrial Physics*, vol. 114, pp. 1–8, 2014
- **Authors:** Clauer is professor, Kim is post-doc, and Deshpande is graduate student, all at Virginia Tech. Lessard is professor at University of New Hampshire. Weatherwax is professor at Siena College. Bust and Crowley are at ASTRA LLC.
  - **Contributions:** Clauer conceived the project. Humphreys developed the instrumentation with input from Bust and Crowley. Clauer, Deshpande, Lessard, Weatherwax

performed the experiment. Kim performed the analysis, with input from Clauer and Humphreys. Kim wrote the paper, with input from Clauer and Humphreys.

J16 K. B. Deshpande, G. S. Bust, C. R. Clauer, H. Kim, J. E. Macon, T. E. Humphreys, J. A. Bhatti, S. B. Musko, G. Crowley, and A. T. Weatherwax, "Initial GPS scintillation results from CASES receiver at South Pole, Antarctica," *Radio Science*, vol. 47, no. 5, 2012

- **Authors:** Clauer and Macon are professors, Kim is post-doc, and Deshpande is graduate student, all at Virginia Tech. Musko is technical staff at the University of Michigan, Ann Arbor. Weatherwax is professor at Siena College. Bust and Crowley are with ASTRA LLC. Bhatti is a graduate student at UT supervised by Humphreys.
- **Contributions:** Clauer and Humphreys conceived the project. Humphreys and Bhatti developed the instrumentation with input from Bust and Crowley. Clauer, Deshpande, Musko, and Weatherwax performed the experiment. Deshpande and Humphreys performed the analysis, with input from Bhatti. Deshpande wrote the paper with input from Clauer, Kim, and Humphreys.

J17 T. E. Humphreys, M. C. Kelley, N. Huber, and P. M. Kintner, "The semidiurnal variation in GPS-derived zenith neutral delay," *Geophysical Research Letters*, vol. 32, no. 24, 2005

- **Authors:** Kelley and Kintner are professors at Cornell. Huber is a graduate student at Cornell.
- **Contributions:** Humphreys conceived the project and conducted the analysis, with input from Kintner, Kelley, and Huber. Humphreys wrote the paper.

## Instrumentation

J18 C. R. Clauer, H. Kim, K. Deshpande, Z. Xu, D. Weimer, S. Musko, G. Crowley, C. Fish, R. Nealy, T. E. Humphreys, J. A. Bhatti, and A. J. Ridley, "Autonomous adaptive low-power instrument platform (AAL-PIP) for remote high latitude geospace data collection," *Geoscientific Instrumentation, Methods and Data Systems*, 2014. (To be published.)

- **Authors:** Clauer is professor, Kim is post-doc, and Weimer, Xu, and Deshpande are graduate students, all at Virginia Tech. Musko is technical staff at the University of Michigan, Ann Arbor. Nealy is technical staff at Virginia Tech. Ridley is professor at the University of Michigan, Ann Arbor. Crowley is with ASTRA LLC. Fish is with Space Dynamics Laboratory. Bhatti is a graduate student at UT supervised by Humphreys.
- **Contributions:** Clauer conceived the project. Humphreys, Musko, Nealy, Ridley, and Bhatti developed the instrumentation with input from Crowley. Clauer, Deshpande, Bhatti, Humphreys, and Musko performed the experiment. Clauer performed the analysis with input from Kim, Deshpande, Humphreys, Fish, Xi, and Weimer. Clauer wrote the paper with input from Kim, Deshpande, Humphreys, Fish, Xi, Ridley, Nealy, and Weimer.

J19 E. G. Lightsey, T. E. Humphreys, J. A. Bhatti, A. J. Joplin, B. W. O'Hanlon, and S. P. Powell, "Demonstration of a space capable miniature dual frequency GNSS receiver," *Navigation, Journal of the Institute of Navigation*, vol. 61, no. 1, pp. 53–64, 2014

- **Authors:** Glenn Lightsey is UT professor. O'Hanlon is Cornell graduate student. Powell is senior technical staff at Cornell. Bhatti and Joplin are graduate students at UT.

- **Contributions:** Humphreys and Lightsey conceived the project. Humphreys, Bhatti, and O'Hanlon developed the instrumentation. Powell and O'Hanlon performed the sounding rocket experiment. Joplin performed the in-lab experiments. Humphreys performed the analysis on the sounding rocket data. Joplin and Humphreys performed the analysis on the in-lab experimental data. Lightsey and Humphreys wrote the paper, with input from Bhatti, Powell, Joplin, and O'Hanlon.

#### REFEREED CONFERENCE PAPERS

**Author contributions are delineated for conference papers published in rank.**

- C1 T. E. Humphreys, D. P. Shepard, J. A. Bhatti, and K. D. Wesson, "A testbed for developing and evaluating GNSS signal authentication techniques," in *Proceedings of the International Symposium on Certification of GNSS Systems and Services (CERGAL)*, (Dresden, Germany), July 2014. (available at <http://radionavlab.ae.utexas.edu/testbed>)
- **Authors:** All co-authors are UT graduate students supervised by Humphreys.
- C2 D. P. Shepard and T. E. Humphreys, "High-precision globally-referenced position and attitude via a fusion of visual SLAM, carrier-phase-based GPS, and inertial measurements," in *Proceedings of the IEEE/ION PLANS Meeting*, May 2014
- **Authors:** All co-authors are UT graduate students supervised by Humphreys.
- C3 A. J. Kerns, K. D. Wesson, and T. E. Humphreys, "A blueprint for civil GPS navigation message authentication," in *Proceedings of the IEEE/ION PLANS Meeting*, May 2014
- **Authors:** All co-authors are UT graduate students supervised by Humphreys.
- C4 K. D. Wesson, B. L. Evans, and T. E. Humphreys, "A probabilistic framework for Global Navigation Satellite System signal timing assurance," in *Proceedings of Asilomar Conference on Signals, Systems, and Computers*, (Pacific Grove, CA), 2013
- **Authors:** Wesson is UT graduate student supervised by Humphreys. Evans is UT professor.
  - **Contributions:** Humphreys and Wesson conceived the project. Wesson conducted the experiments with input from Humphreys. Wesson and Humphreys performed the analysis. Wesson wrote the paper with input from Humphreys and Evans.
- C5 K. D. Wesson, B. L. Evans, and T. E. Humphreys, "A combined symmetric difference and power monitoring GNSS anti-spoofing technique," in *IEEE Global Conference on Signal and Information Processing*, 2013
- **Authors:** Wesson is UT graduate student supervised by Humphreys. Evans is UT professor.
  - **Contributions:** Humphreys and Wesson conceived the project. Wesson conducted the experiments with input from Humphreys. Wesson and Humphreys performed the analysis. Wesson wrote the paper with input from Humphreys and Evans.
- C6 Z. M. Kassas, J. A. Bhatti, and T. E. Humphreys, "A graphical approach to GPS software-defined receiver implementation," in *Proceedings of IEEE Global Conference on Signal and Information Processing*, December 2013
- **Authors:** All co-authors are UT graduate students supervised by Humphreys.

- C7 Z. Kassas and T. E. Humphreys, "The price of anarchy in active signal landscape map building," in *Proceedings of IEEE Global Conference on Signal and Information Processing*, December 2013
- **Authors:** All co-authors are UT graduate students supervised by Humphreys.
- C8 Z. Kassas, J. A. Bhatti, and T. E. Humphreys, "Receding horizon trajectory optimization for simultaneous signal landscape mapping and receiver localization," in *Proceedings of the ION GNSS+ Meeting*, September 2013
- **Authors:** All co-authors are UT graduate students supervised by Humphreys.
- C9 K. M. Pesyna Jr., R. W. Heath Jr., and T. E. Humphreys, "Precision limits of low-energy GNSS receivers," in *Proceedings of the ION GNSS+ Meeting*, (Nashville, Tennessee), Institute of Navigation, 2013
- **Authors:** Pesyna is a UT graduate student supervised by Humphreys. Heath is UT professor and co-supervisor of Pesyna.
  - **Contributions:** Humphreys and Pesyna conceived the project and did the experiments and analysis. Pesyna and Humphreys wrote the paper with input from Heath.
- C10 Z. M. Kassas and T. E. Humphreys, "Motion planning for optimal information gathering in opportunistic navigation systems," in *AIAA Guidance, Navigation, and Control Conference (GNC'13)*, (Boston, MA), pp. 4551–4565, Aug. 2013
- **Authors:** All co-authors are UT graduate students supervised by Humphreys.
- C11 K. D. Wesson, T. E. Humphreys, and B. L. Evans, "Position paper: Secure time transfer for CPS," in *NSF/NSA National Workshop on The New Clockwork for Time-Critical Systems*, 2012
- **Authors:** Wesson is UT graduate student supervised by Humphreys. Evans is UT professor.
  - **Contributions:** Humphreys and Wesson conceived the project. Wesson conducted the experiments with input from Humphreys. Wesson and Humphreys performed the analysis. Wesson wrote the paper with input from Humphreys and Evans.
- C12 D. P. Shepard, K. M. Pesyna, and T. E. Humphreys, "Precise augmented reality enabled by carrier-phase differential GPS," in *Proceedings of the ION GNSS Meeting*, (Nashville, Tennessee), Institute of Navigation, 2012
- **Authors:** All co-authors are UT graduate students supervised by Humphreys.
- C13 D. P. Shepard, J. A. Bhatti, T. E. Humphreys, and A. A. Fansler, "Evaluation of smart grid and civilian UAV vulnerability to GPS spoofing attacks," in *Proceedings of the ION GNSS Meeting*, 2012
- **Authors:** Shepard and Bhatti are UT graduate students supervised by Humphreys, Fansler is collaborator from Northrop Grumman Corp.
  - **Contributions:** Humphreys and Shepard conceived the project. Shepard, Humphreys, Bhatti, and Fansler conducted the analysis and experiments. Shepard and Humphreys wrote the paper with input from Fansler and Bhatti.
- C14 Z. M. Kassas and T. E. Humphreys, "Observability and estimability of collaborative opportunistic navigation with pseudorange measurements," in *Proceedings of the ION GNSS Meeting*, (Nashville, Tennessee), Institute of Navigation, 2012
- **Authors:** All co-authors are UT graduate students supervised by Humphreys.

- C15 T. E. Humphreys, J. A. Bhatti, D. P. Shepard, and K. D. Wesson, "The Texas Spoofing Test Battery: Toward a standard for evaluating GNSS signal authentication techniques," in *Proceedings of the ION GNSS Meeting*, 2012. <http://radionavlab.ae.utexas.edu/texbat>
- **Authors:** All co-authors are UT graduate students supervised by Humphreys.
- C16 Z. M. Kassas and T. E. Humphreys, "Observability analysis of opportunistic navigation with pseudorange measurements," in *Proceedings of AIAA Guidance, Navigation, and Control Conference*, Aug. 2012
- **Authors:** All co-authors are UT graduate students supervised by Humphreys.
- C17 J. A. Bhatti, T. E. Humphreys, and B. M. Ledvina, "Development and demonstration of a TDOA-based GNSS interference signal localization system," in *Proceedings of the IEEE/ION PLANS Meeting*, pp. 1209–1220, April 2012
- **Authors:** Ledvina is with Coherent Navigation, Inc. Bhatti is UT graduate student supervised by Humphreys.
  - **Contributions:** Humphreys and Bhatti conceived the project and conducted the experiments and analysis. Bhatti wrote the paper with input from Humphreys and Ledvina.
- C18 K. M. Pesyna, Z. M. Kassas, and T. E. Humphreys, "Constructing a continuous phase time history from TDMA signals for opportunistic navigation," in *Proceedings of the IEEE/ION PLANS Meeting*, pp. 1209–1220, April 2012
- **Authors:** All co-authors are UT graduate students supervised by Humphreys.
- C19 D. Shepard, T. E. Humphreys, and A. Fansler, "Evaluation of the vulnerability of Phasor Measurement Units to GPS spoofing," in *Sixth Annual IFIP WG 11.10 International Conference on Critical Infrastructure Protection*, (Washington, DC), Mar. 2012
- **Authors:** Shepard is UT graduate student supervised by Humphreys, Fansler is collaborator from Northrop Grumman Corp.
  - **Contributions:** Humphreys and Shepard conceived the project. Shepard, Humphreys, and Fansler conducted the analysis and experiments. Shepard and Humphreys wrote the paper with input from Fansler.
- C20 A. J. Joplin, E. G. Lightsey, and T. E. Humphreys, "Development and testing of a miniaturized, dual-frequency GPS receiver for space applications," in *Proceedings of the ION International Technical Meeting*, (Long Beach, CA), Jan. 2012
- **Authors:** Glenn Lightsey is professor at UT. Joplin is graduate student at UT co-supervised by Lightsey and Humphreys.
  - **Contributions:** Humphreys and Lightsey conceived the project. Humphreys developed the instrumentation. Joplin performed the experiments. Joplin and Humphreys performed the analysis. Joplin wrote the paper with input from Humphreys and Lightsey.
- C21 K. D. Wesson, M. P. Rothlisberger, and T. E. Humphreys, "A proposed navigation message authentication implementation for civil GPS anti-spoofing," in *Proceedings of the ION GNSS Meeting*, (Portland, Oregon), Institute of Navigation, 2011
- **Authors:** All co-authors are UT graduate students supervised by Humphreys.

- C22 D. Shepard and T. E. Humphreys, "Characterization of receiver response to a spoofing attack," in *Proceedings of the ION GNSS Meeting*, (Portland, Oregon), Institute of Navigation, 2011
- **Authors:** All co-authors are UT graduate students supervised by Humphreys.
- C23 R. Mitch, R. Dougherty, M. Psiaki, S. Powell, B. O'Hanlon, J. Bhatti, and T. Humphreys, "Signal characteristics of civil GPS jammers," in *Proceedings of the ION GNSS Meeting*, 2011
- **Authors:** Mitch, O'Hanlon, and Dougherty are Cornell graduate student, Psiaki is professor at Cornell (and former Humphreys supervisor), Powell is senior technical staff at Cornell, Bhatti is UT graduate students supervised by Humphreys.
  - **Contributions:** Humphreys, Psiaki, Mitch, and Bhatti conceived the project. Bhatti, Mitch, O'Hanlon, and Powell performed the experiments. Mitch performed the analysis, with input from Psiaki and Bhatti. Mitch wrote the paper with input from Psiaki and Humphreys.
- C24 M. L. Psiaki, B. W. O'Hanlon, J. A. Bhatti, and T. E. Humphreys, "Civilian GPS spoofing detection based on dual-receiver correlation of military signals," in *Proceedings of the ION GNSS Meeting*, (Portland, Oregon), Institute of Navigation, 2011
- **Authors:** Psiaki is Professor at Cornell (and former Humphreys supervisor), O'Hanlon is Cornell graduate student, Bhatti is UT graduate students supervised by Humphreys.
  - **Contributions:** Psiaki conceived the project with input from Humphreys. O'Hanlon, Bhatti, and Psiaki conducted the analysis and experiments with input from Humphreys. Psiaki wrote the paper with input from Humphreys.
- C25 G. Crowley, G. S. Bust, A. Reynolds, I. Azeem, R. Wilder, B. W. O'Hanlon, M. L. Psiaki, S. Powell, T. E. Humphreys, and J. A. Bhatti, "CASES: A novel low-cost ground-based dual-frequency GPS software receiver and space weather monitor," in *Proceedings of the ION GNSS Meeting*, (Portland, Oregon), Institute of Navigation, 2011
- **Authors:** Crowley, Bust, Reynolds, Azeem, and Wilder are with ASTRA LLC, Psiaki is professor at Cornell (and former Humphreys supervisor), O'Hanlon is Cornell graduate student, Powell is senior technical staff at Cornell, Bhatti is UT graduate student supervised by Humphreys.
  - **Contributions:** Humphreys and Psiaki conceived the project, with input from ASTRA contributors. Humphreys, Bhatti, and O'Hanlon developed the instrument, performed the experiments, and conducted the analysis, with input from Reynolds. Crowley wrote the paper with input from all other co-authors.
- C26 B. O'Hanlon, M. Psiaki, S. Powell, J. Bhatti, T. E. Humphreys, G. Crowley, and G. Bust, "CASES: A smart, compact GPS software receiver for space weather monitoring," in *Proceedings of the ION GNSS Meeting*, (Portland, Oregon), pp. 2745–2753, Institute of Navigation, 2011
- **Authors:** Crowley and Bust are with ASTRA LLC, Psiaki is professor at Cornell (and former Humphreys supervisor), O'Hanlon is Cornell graduate student, Powell is senior technical staff at Cornell, Bhatti is UT graduate student supervised by Humphreys.
  - **Contributions:** Humphreys and Psiaki conceived the project. Humphreys, Bhatti, and O'Hanlon developed the instrument, performed the experiments, and conducted

- the analysis, with input from Psiaki. O'Hanlon wrote the paper with input from all other co-authors.
- C27 K. D. Wesson, D. P. Shepard, J. A. Bhatti, and T. E. Humphreys, "An evaluation of the vestigial signal defense for civil GPS anti-spoofing," in *Proceedings of the ION GNSS Meeting*, (Portland, OR), 2011
- **Authors:** All co-authors are UT graduate students supervised by Humphreys.
- C28 K. Pesyna, Z. Kassas, J. Bhatti, and T. E. Humphreys, "Tightly-coupled opportunistic navigation for deep urban and indoor positioning," in *Proceedings of the ION GNSS Meeting*, (Portland, Oregon), Institute of Navigation, 2011
- **Authors:** All co-authors are UT graduate students supervised by Humphreys.
- C29 K. M. Pesyna, Jr., K. D. Wesson, R. W. Heath, Jr., and T. E. Humphreys, "Extending the reach of GPS-assisted femtocell synchronization and localization through tightly-coupled opportunistic navigation," in *IEEE GLOBECOM Workshop*, 2011
- **Authors:** Pesyna and Wesson are UT graduate students supervised by Humphreys. Heath is UT professor and co-supervisor of Pesyna.
  - **Contributions:** Humphreys and Pesyna conceived the project and did the experiments and analysis with input from Wesson. Pesyna and Humphreys wrote the paper with input from Wesson and Heath.
- C30 B. O'Hanlon, J. Bhatti, T. E. Humphreys, and M. Psiaki, "Real-time spoofing detection in a narrow-band civil GPS receiver," in *Proceedings of the ION GNSS Meeting*, (Portland, Oregon), Institute of Navigation, 2010
- **Authors:** O'Hanlon is Cornell graduate student, Psiaki is professor at Cornell (and former Humphreys supervisor), Bhatti is UT graduate student supervised by Humphreys.
  - **Contributions:** Psiaki, O'Hanlon, and Bhatti conceived the project. O'Hanlon and Bhatti conducted the analysis and experiments with guidance from Humphreys. O'Hanlon wrote the paper with input from Psiaki and Humphreys.
- C31 T. E. Humphreys, J. Bhatti, and B. Ledvina, "The GPS Assimilator: a method for upgrading existing GPS user equipment to improve accuracy, robustness, and resistance to spoofing," in *Proceedings of the ION GNSS Meeting*, (Portland, Oregon), Institute of Navigation, 2010
- **Authors:** Bhatti is UT graduate student supervised by Humphreys. Ledvina is with Coherent Navigation, Inc.
  - **Contributions:** Humphreys and Ledvina conceived the project. Humphreys, Bhatti, and Ledvina developed the instrument, conducted the experiments, and performed the analysis. Humphreys wrote the paper with input from Ledvina.
- C32 K. Wesson, K. Pesyna, J. Bhatti, and T. E. Humphreys, "Opportunistic frequency stability transfer for extending the coherence time of GNSS receiver clocks," in *Proceedings of the ION GNSS Meeting*, (Portland, Oregon), Institute of Navigation, 2010
- **Authors:** All co-authors are UT graduate students supervised by Humphreys.
- C33 T. E. Humphreys, J. Bhatti, T. Pany, B. Ledvina, and B. O'Hanlon, "Exploiting multicore technology in software-defined GNSS receivers," in *Proceedings of the ION GNSS Meeting*, (Savannah, GA), pp. 326–338, Institute of Navigation, 2009
- **Authors:** Bhatti is UT graduate student supervised by Humphreys, O'Hanlon is Cornell graduate student, Ledvina is with Coherent Navigation, Inc, Pany is with IFEN, GmbH.

- **Contributions:** Humphreys conceived the project. Humphreys and Bhatti developed the instrumentation and performed the experiments and analysis. Humphreys wrote the paper with input from Pany and Ledvina.
- C34 B. W. O'Hanlon, M. L. Psiaki, P. M. Kintner, Jr., and T. E. Humphreys, "Development and field testing of a DSP-based dual-frequency software GPS receiver," in *Proceedings of the ION GNSS Meeting*, (Savannah, GA), Institute of Navigation, 2009
- **Authors:** Psiaki and Kintner are professors at Cornell (and former Humphreys supervisors), O'Hanlon is Cornell graduate student.
  - **Contributions:** Humphreys, Psiaki, and Kintner conceived the project. Humphreys and O'Hanlon developed the instrument, performed the experiments, and conducted the analysis, with input from Psiaki and Kintner. O'Hanlon wrote the paper with input from all other co-authors.
- C35 T. E. Humphreys, B. M. Ledvina, M. L. Psiaki, B. W. O'Hanlon, and P. M. Kintner, Jr., "Assessing the spoofing threat: Development of a portable GPS civilian spoofer," in *Proceedings of the ION GNSS Meeting*, (Savannah, GA), Institute of Navigation, 2008
- C36 J. C. Hinks, T. E. Humphreys, B. O'Hanlon, M. L. Psiaki, and P. M. Kintner, Jr., "Evaluating GPS receiver robustness to ionospheric scintillation," in *Proceedings of the ION GNSS Meeting*, (Savannah, GA), Institute of Navigation, 2008
- C37 S. Mohiuddin, T. E. Humphreys, and M. L. Psiaki, "A technique for determining the carrier phase differences between independent GPS receivers during scintillation," *Proceedings of the ION GNSS Meeting*, 2007
- C38 M. L. Psiaki, T. E. Humphreys, S. Mohiuddin, S. P. Powell, A. P. Cerruti, and P. M. Kintner, Jr., "Searching for Galileo," in *Proceedings of the ION GNSS Meeting*, (Fort Worth, TX), Institute of Navigation, 2006
- C39 T. E. Humphreys, B. M. Ledvina, M. L. Psiaki, and P. M. Kintner, Jr., "GNSS receiver implementation on a DSP: Status, challenges, and prospects," in *Proceedings of the ION GNSS Meeting*, (Fort Worth, TX), pp. 2370–2382, Institute of Navigation, 2006
- C40 T. E. Humphreys, M. L. Psiaki, B. M. Ledvina, and P. M. Kintner, Jr., "GPS carrier tracking loop performance in the presence of ionospheric scintillations," in *Proceedings of the ION GNSS Meeting*, (Long Beach, CA), Institute of Navigation, Sept. 2005
- C41 T. E. Humphreys, B. M. Ledvina, M. L. Psiaki, and P. M. Kintner, "Analysis of ionospheric scintillations using wideband GPS L1 C/A signal data," in *Proceedings of the ION GNSS Meeting*, (Long Beach, California), pp. 399–407, Institute of Navigation, 2004
- C42 T. E. Humphreys, M. Kelley, and P. M. Kintner, Jr., "GPS-based measurement of atmospheric tides," in *Proceedings of the ION GNSS Meeting*, (Long Beach, California), pp. 864–880, Institute of Navigation, 2004
- C43 T. E. Humphreys, "Attitude determination for small satellites with modest pointing constraints," in *Proc. 2002 AIAA/USU Small Satellite Conference*, (Logan, Utah), 2002

THE UNIVERSITY OF TEXAS AT AUSTIN

*E-mail address:* todd.humphreys@mail.utexas.edu

WORKS FORTHCOMING

TODD HUMPHREYS

Refereed Journal Articles: Accepted yet Unpublished

- J8 Z. M. Kassas and T. E. Humphreys, "Receding horizon trajectory optimization in opportunistic navigation environments," *IEEE Transactions on Aerospace and Electronic Systems*, 2014. (To be published.)
- J18 C. R. Clauer, H. Kim, K. Deshpande, Z. Xu, D. Weimer, S. Musko, G. Crowley, C. Fish, R. Nealy, T. E. Humphreys, J. A. Bhatti, and A. J. Ridley, "Autonomous adaptive low-power instrument platform (AAL-PIP) for remote high latitude geospace data collection," *Geoscientific Instrumentation, Methods and Data Systems*, 2014. (To be published.)

The University of Texas at Austin

*E-mail address:* todd.humphreys@mail.utexas.edu

**Gonzales, Laurie**

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**From:** Noel Clemens  
**Sent:** Monday, September 08, 2014 10:43 AM  
**To:** todd.humphreys@mail.utexas.edu  
**Cc:** Gonzales, Laurie  
**Subject:** RE: TAES-201400022R Decision Letter

Great. I have finished it but I can still modify it. You can modify your statement too. Definitely update the table.

It is with your student, right?

N

**From:** [todd.humphreys@gmail.com](mailto:todd.humphreys@gmail.com) [mailto:[todd.humphreys@gmail.com](mailto:todd.humphreys@gmail.com)] **On Behalf Of** Todd Humphreys  
**Sent:** Monday, September 08, 2014 10:39 AM  
**To:** Noel Clemens  
**Subject:** Fwd: TAES-201400022R Decision Letter

Noel,

One of the three papers I've got under review was just accepted in a top journal in my field, in case you haven't yet finished your assessment letter. See below.

Best,  
Todd

----- Forwarded message -----

From: <[taes@msubmit.net](mailto:taes@msubmit.net)>  
Date: Mon, Sep 8, 2014 at 9:41 AM  
Subject: TAES-201400022R Decision Letter  
To: [zkassas@ieee.org](mailto:zkassas@ieee.org)  
Cc: [todd.humphreys@mail.utexas.edu](mailto:todd.humphreys@mail.utexas.edu), [rjanssen@allenpress.com](mailto:rjanssen@allenpress.com)

"Receding Horizon Trajectory Optimization in Opportunistic Navigation Environments"

Dear Prof. Kassas:

On behalf of the IEEE Transactions on Aerospace and Electronic Systems (TAES), I am pleased to accept your above referenced manuscript for publication. The IEEE AESS Editorial Office will contact you with the requirements for your Final Submission Package, and your timely response will minimize publication delays.

Please note that if your manuscript was first submitted November 1 of 2010 or later you have agreed to our mandatory page-charge policy: \$200 for every printed page beyond 10 (for a regular paper) and beyond 6 (for a correspondence); and \$250 for every page in a "Letter".

You may still request your article be published with unrestricted public access, as this is a hybrid journal allowing either Traditional manuscript submission or Open Access (author-pays OA) manuscript submission. Authors who choose open access must do so by notifying the Editor-In-Chief at this time. A fee of \$1750 will be billed. This fee is independent of contribution type or article length, although over-length page

charges are still applicable and are in addition to it. For any questions regarding IEEE's Open Access policy, please refer to our Frequently Asked Questions on Open Access  
[http://www.ieee.org/documents/ieee\\_open\\_access\\_faq\\_2011.pdf](http://www.ieee.org/documents/ieee_open_access_faq_2011.pdf).

In some cases a manuscript was initially submitted as a regular paper but has been accepted as a correspondence item; this may result in an increase in the mandatory page charges. You may reduce the length, but if this requires significant modification you must contact the accepting Associate Editor for approval, as the accepted and final manuscripts will be cross-checked.

Thank you for your contribution to the IEEE Transactions on Aerospace and Electronic Systems.

Sincerely,  
Kegen Yu

**Gonzales, Laurie**

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**From:** todd.humphreys@gmail.com on behalf of Todd Humphreys  
<todd.humphreys@mail.utexas.edu>  
**Sent:** Thursday, September 11, 2014 9:14 PM  
**To:** Noel Clemens  
**Cc:** Gonzales, Laurie  
**Subject:** Fwd: gi-2014-9 (Author) - Manuscript accepted for Final Publication  
**Attachments:** resumeHumphreys.pdf; co-authoredWorks.pdf; researchStatement.pdf

Noel,

Journal paper J18 on my CV was just accepted for publication (see below). This paper was written with my student Jahshan Bhatti and co-authors from Virginia Tech. Not sure if we can modify the packet now that we sent it along to the dean's office, but I've attached revised documents just in case. Perhaps Laurie could update the appropriate tables.

Best,  
Todd

----- Forwarded message -----

From: <[editorial@copernicus.org](mailto:editorial@copernicus.org)>  
Date: Thu, Sep 11, 2014 at 4:24 PM  
Subject: gi-2014-9 (Author) - Manuscript accepted for Final Publication  
To: [todd.humphreys@mail.utexas.edu](mailto:todd.humphreys@mail.utexas.edu)

You are receiving the following email copy due to your co-authorship of the manuscript gi-2014-9. The original message was sent to the contact author defined upon manuscript registration. Please contact us in case of any discrepancies with regard to the manuscript.

Please consider creating your personal ORCID (Open Researcher and Contributor ID) or connect your Copernicus Office user account with your ORCID: <https://orcid.org/oauth/signin>

Dear Robert Clauer,

We are pleased to inform you that your following manuscript was accepted for final publication in GI:

Title: Autonomous Adaptive Low-Power Instrument Platrform (AAL-PIP) for remote high latitude geospace data collection

Author(s): C. R. Clauer et al.

MS No.: gi-2014-9

MS Type: Research Article

Iteration: Revised Submission

Presently, your manuscript is being transferred to the Copernicus Publications Production Office for typesetting and publication. To proceed, please upload all files that are required for production no later than 21 Sep 2014 at [http://editor.copernicus.org/GI/file\\_manager/gi-2014-9](http://editor.copernicus.org/GI/file_manager/gi-2014-9). For further information on files and formats we kindly refer you to the submission guidelines: <http://www.geoscientific-instrumentation-methods-and-data->

systems.net/submission/manuscript\_submission.html

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In case any questions arise, please contact me!

Kind regards,

Natascha Töpfer  
Copernicus Publications  
Editorial Support  
[editorial@copernicus.org](mailto:editorial@copernicus.org)

on behalf of the GI Editorial Board

--  
Todd E. Humphreys | Assistant Professor | Aerospace Engineering  
The University of Texas at Austin  
210 E. 24th St. Stop C0600  
Austin, TX 78712-1221  
Office: WRW 411C  
Phone: (512) 471-4489  
Web: <http://radionavlab.ae.utexas.edu/>

**Leaves of Absence – Todd Humphreys**

No leaves without pay were taken Dr. Humphreys' period in rank, 9/1/2009 – present.

**Statistical Summary for “In Rank”  
Todd Humphreys**

Metric	Value
Peer-reviewed Journal Publications	16
Peer-reviewed Conference Publications	34
Corresponding Author on Peer-Reviewed Publications	9/14 journal; 28/34 conference
Total Citations of all Publications (career)*	933
h-index (career)*	19
Google Scholar Total Citations of all Publications (career)	933
Google Scholar h-index (career)	19
Total Research Funding (\$)	\$4,567,640
Candidate Share Research Funding (\$)	\$1,824,640
Total Number of Grants/Contracts Received	20 (14 external)
Number of Grants/Contracts Received as PI	18 (13 external)
PhD Students Completed (count 1 if sole advisor, 0.5 if co-advised)	0.5 + 0.5 = 1 (NB: Humphreys was <i>primary</i> advisor for both students)
MS Students Completed (count 1 if sole advisor, 0.5 if co-advised)	1
PhD Students in Pipeline (as of 09/2014) (count 1 if sole advisor, 0.5 if co-advised)	0.5 + 4 = 4.5 (NB: Humphreys is <i>primary</i> advisor for the one co-advised student)
MS students in Pipeline (as of 09/2014) (count 1 if sole advisor, 0.5 if co-advised)	0
Courses Taught	10
# of Students Taught	246
Average Instructor Evaluation UG	4.74
Average Instructor Evaluation Grad	4.76
Average Course Evaluation UG	4.56
Average Course Evaluation Grad	4.66
Teaching Awards	UT Regents’ Teaching Award
Student Organizations Advised	AIAA Student Organization
Undergraduates Supervised	3
Journal Editorial Boards	1 (IEEE Transactions on Wireless Communications)
Symposia Organized	2 (2013 Texas Wireless Summit; 2010 Civil GNSS Security Meeting)

\*Source:

- Publish or Perish (with Google Scholar input)
- ISI Web of Knowledge

**Faculty Annual Report for Year End August 31, 2012****Todd Humphreys**

Assistant Professor

**Aerospace Engineering and Engineering Mechanics Department**Signature: Todd Humphreys 10/2/12  
10/2/12**Part 1: Teaching Activities****A. COURSES TAUGHT****Organized Classes**

SEMESTER TAUGHT	COURSE NO.	COURSE NAME	NO. SECTIONS/STUDENTS
Fall 2011	ASE 372N	Satellite-Based Navigation	1 14
Spring 2012	ASE 396	Model-Based Detection/Estimation	1 24

**Individual Instructions**

SEMESTER TAUGHT	COURSE NO.	COURSE NAME	NO. SECTIONS/STUDENTS
Fall 2011	ASE 397K	4-Research in Orbital Mechanics	1 1
Fall 2011	EM 397C	Research Problems	1 1
Fall 2011	EM 697C	Research Problems	1 1
Fall 2011	EM 997C	Research Problems	1 1
Spring 2012	ASE 697K	4-Research in Orbital Mechanics	1 1
Spring 2012	EM 397C	Research Problems	1 1
Spring 2012	EM 697C	Research Problems	1 2
Summer 2012	ASE 397K	4-Research in Orbital Mechanics	1 1
Summer 2012	ASE W698A	Thesis	1 1
Summer 2012	EM W397C	Research Problems	1 2
Summer 2012	EM S397C	Research Problems	1 1

**B. GRADUATE STUDENT RESEARCH****Supervisor, PhD Dissertations**

STUDENT	DEPARTMENT	GRAD. DATE	AREA
Jashan Bhatti	ASE/EM		
Kyle Wesson	ECE		
Ken Pesyna	ECE		
Zak Kassas	ECE		
Daniel Shepard	ASE/EM		

**Supervisor, MS Theses/Reports**

STUDENT	DEPARTMENT	GRAD. DATE	AREA

**Co-Supervisor, PhD Dissertations**

STUDENT	DEPARTMENT	GRAD. DATE	AREA

**Co-Supervisor, MS Theses/Reports**

STUDENT	DEPARTMENT	GRAD_DATE	AREA
Bright, Marlon	ASE/EM	Summer 2012	
Joplin, Andrew	ASE/EM	Fall 2011	

**Member PhD Committees**

STUDENT	DEPARTMENT	GRAD_DATE	AREA
Kien T. Truong	Electrical & Computer Engineering	Spring 2012	
Yousof Mortazavi	Electrical & Computer Engineering		
Thomas Novlan	Electrical & Computer Engineering	Spring 2012	
Noah Smith	ASE/EM	Fall 2012	
Kumar Appaiah	Electrical & Computer Engineering		
Vidur Bhargava	Electrical & Computer Engineering		

**Reader, MS Committees**

STUDENT	DEPARTMENT	GRAD_DATE	AREA

**C. OTHER RESEARCH SUPERVISION****Other Categories****D. ADDITIONAL TEACHING ACTIVITIES**

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**Part 2: Administrative And Committee Assignments**

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**A. ADMINISTRATIVE COMMITTEES****B. UNIVERSITY COMMITTEES****University****College**

Cockrell School Honors Committee, 2011-present

**Department**

Department Chair Search Committee, 2012

**C. OUTSIDE COMMITTEES****International****National**

Member, American Institute of Aeronautics and Astronautics (AIAA)  
 Member, Institute of Electrical and Electronics Engineers (IEEE)  
 Member, Institute of Navigation

**State**

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**Part 3: Contributions to Technology**

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**A. REFEREED ARCHIVAL JOURNALS**

1. Humphreys, T. E., "Detection Strategy for Cryptographic GNSS Anti-Spoofing," IEEE Transactions on Aerospace and Electronic Systems, to be published.
2. Wesson, K., Rothlisberger, M., and Humphreys, T. E., "Practical Cryptographic Civil GPS Signal Authentication," NAVIGATION: The Journal of the Institute of Navigation, to be published.
3. Psiaki, M.L., B.W. O'Hanlon, J.A. Bhatti, D.P. Shepard, and T.E. Humphreys, "GPS Spoofing Detection via Dual-Receiver Correlation of Military Signals," IEEE Transactions on Aerospace and Electronic Systems, to be published.
4. Deshpande, K., Bust, G. S., Clauer, C. R., Kim, H., Macon, J. E., Humphreys, T.E., Bhatti, J.A., Musko, S. B., Crowley, G., and Weatherwax, A. T., "Initial GPS Scintillation results from CASES receiver at South Pole, Antarctica, Radio Science, 2012, to be published.
5. Kassas, Z. M. and Humphreys, T. E., "Observability Analysis of Collaborative Opportunistic Navigation with Pseudorange Measurements," IEEE Transactions on Intelligent Transportation Systems, 2012, submitted for review.

**B. REFEREED CONFERENCE PROCEEDINGS**

1. Pesyna, K., Kassas, Z., Bhatti, J., and Humphreys, T. E., "Tightly-Coupled Opportunistic Navigation for Deep Urban and Indoor Positioning," Proc. ION GNSS, Institute of Navigation, Portland, Oregon, 2011.
2. Wesson, K., Shepard, D., Bhatti, J., and Humphreys, T. E., "An Evaluation of the Vestigial Signal Defense for Civil GPS Anti-Spoofing," Proc. ION GNSS, Institute of Navigation, Portland, Oregon, 2011.
3. O'Hanlon, B., Psiaki, M., Powell, S., Bhatti, J., Humphreys, T. E., Crowley, G., and Bust, G., "CASES: A Smart, Compact GPS Software Receiver for Space Weather Monitoring," Proc. ION GNSS, Institute of Navigation, Portland, Oregon, 2011.
4. Mitch, R.H., R.C. Dougherty, M.L. Psiaki, S.P. Powell, B.W. O'Hanlon, J.A. Bhatti, and T.E. Humphreys, "Signal Characteristics of Civil GPS Jammers," Proc. ION GNSS, Institute of Navigation, Portland, Oregon, 2011.
5. Psiaki, M.L., B.W. O'Hanlon, J.A. Bhatti, D.P. Shepard, T.E. Humphreys, "Civilian GPS Spoofing Detection based on Dual-Receiver Correlation of Military Signals," Proc. ION GNSS, Institute of Navigation, Portland, Oregon, 2011.
6. Crowley, G., Bust, G.S., Reynolds, A., Azeem, I., Wilder, R., O'Hanlon, B.W., Psiaki, M.L., Powell, S., Humphreys, T.E., and Bhatti, J.A., "CASES: A Novel Low-Cost Ground-based Dual-Frequency GPS Software Receiver and Space Weather Monitor," Proceedings of the ION GNSS Meeting, Institute of Navigation, Portland, Oregon, 2011.
7. Shepard, D., and Humphreys, T. E., "Characterization of Receiver Response to a Spoofing Attack," Proceedings of the ION GNSS Meeting, Institute of Navigation, Portland, Oregon, 2011.
8. Wesson, K. D., Rothlisberger, M. P., and Humphreys, T. E., "A Proposed Navigation Message Authentication Implementation for Civil GPS Anti-Spoofing," Proceedings of the ION GNSS Meeting, Institute of Navigation, Portland, Oregon, 2011.
9. Pesyna, Jr., K. M., K. D. Wesson, R. W. Heath, Jr., T. E. Humphreys, "Extending the Reach of GPS-assisted Femtocell Synchronization and Localization Through Tightly-Coupled Opportunistic Navigation," Proc. IEEE GLOBECOM Workshops, Houston, TX, 2011.
10. Joplis, A. J., E. G. Lightsey, T.E. Humphreys, "Development and Testing of a Minaturized, Dual-Frequency GPS Receiver for Space Applications," Proc. ION ITM, Institute of Navigation, Newport Beach, California, 2012.
11. Shepard, D. P., T. E. Humphreys, and A. A. Fansler, "Evaluation of the Vulnerability of Phasor Measurement Units to GPS Spoofing Attacks," Sixth Annual IFIP WG 11.10 International Conference on Critical Infrastructure Protection, Washington, DC, 2012.

12. Bhatti, J. A., T.E. Humphreys, and B.M. Ledvina, "Development and Demonstration of a TDOA-Based GNSS Interference Signal Localization System," Proc. IEEE/ION Position Location and Navigation System (PLANS) Conf., Myrtle Beach, SC, 2012. (Winner of the conference's Walter Fried award for best overall technical paper.)
13. Pesyna, K.M. Jr., Z.M. Kassas, and T.E. Humphreys, "Constructing a Continuous Phase Time History from TDMA Signals for Opportunistic Navigation," Proc. IEEE/ION Position Location and Navigation System (PLANS) Conf., Myrtle Beach, SC, 2012. (Winner of the conference's best student paper award.)
14. Kassas, Z. M., and Humphreys, T. E., "Observability Analysis of Opportunistic Navigation with Pseudorange Measurements," Proceedings of AIAA Guidance, Navigation, and Control Conference, Aug. 2012.

### C. NON-REFEREED PAPERS

1. Mitch, R.H., R.C. Dougherty, M.L. Psiaki, S.P. Powell, B.W. O'Hanlon, J.A. Bhatti, and T.E. Humphreys, "Know Your Enemy Signal Characteristics of Civil GPS Jammers," GPS World, January, 2012.
2. Wesson, K., D. Shepard, and T. Humphreys, "Straight Talk on Anti-Spoofing: Securing the Future of PNT," GPS World, January, 2012.
3. Humphreys, T. E., "The GPS Dot and Its Discontents: Privacy vs. GNSS Integrity," InsideGNSS, April, 2012.
4. Shepard, D. P., Humphreys, T. E., and Fansler, A. A., "Going Up Against Time: The Power Grid's Vulnerability to GPS Spoofing Attacks," GPS World, Aug. 2012.
5. Shepard, D. P., Bhatti, J. A., and Humphreys, T. E., "Drone Hack: Spoofing Attack Demonstration on a Civilian Unmanned Aerial Vehicle," GPS World, Aug. 2012
6. Humphreys, T. E., "Statement on the vulnerability of civil unmanned aerial vehicles and other systems to civil GPS spoofing, <http://homeland.house.gov/sites/homeland.house.gov/files/Testimony-Humphreys.pdf>, July 2012.

### D. BOOKS AUTHORED/CO-AUTHORED

### E. BOOKS EDITED/CO-EDITED

### F. BOOKS CHAPTERS

### G. BOUND TECHNICAL REPORTS

### H. ORAL PRESENTATIONS

1. Humphreys, T. E., "Cubesat-Sized Radio Occultation Experiments," Massachusetts Institute of Technology Aeronautics and Astronautics Department, December 2011, invited presentation.
2. Humphreys, T. E., "The GPS Dot and its Discontents," TEDxAustin, February, 2012, invited presentation.
3. Humphreys, T. E., "PVT Security: Privacy and Trustworthiness," Conference on GNSS Vulnerability: Present Dangers, Future Threats 2012, Teddington, UK, February 2012, invited keynote presentation.
4. Humphreys, T. E., "Privacy vs. GPS Integrity," Civil GPS Service Interface Committee (CGSIC) Meeting, Austin TX, June 2012, invited presentation.
5. Humphreys, T. E., "Statement on the vulnerability of civil unmanned aerial vehicles and other systems to civil GPS spoofing," Washington, DC, July 2012, invited congressional testimony.
6. Humphreys, T. E., "Radionavigation Robustness and Security," Office of Naval Research, Arlington VA, July 2012, invited presentation.
7. Humphreys, T. E., "Secure Civil Navigation and Timing," MITRE corporation and government customers, McLean VA, July 2012, invited presentation.

### I. PATENTS

Humphreys, T. E., J. Bhatti., D. Shepard, "Radionavigation Security Testbed Software," software disclosure submitted to the UT Office of Technology Commercialization, 2012.

#### J. COPYRIGHTED SOFTWARE

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#### Part 4: Research Activities/Grants & Contracts

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##### A. PROJECTS FUNDED-INDIVIDUAL

<u>Begin/end Dates</u>	<u>Total Award</u>	<u>Your 11-12 Portion</u>	<u>Reporting Center</u>	<u>Sponsor</u>
8/2012 – 11/2012	\$40,083			Sandia National Laboratory
<u>Project Title</u>	"GPS vulnerability simulation support"			

##### B. PROJECTS FUNDED-JOINT

<u>Begin/end Dates</u>	<u>Total Award</u>	<u>Your 11-12 Portion</u>	<u>Reporting Center</u>	<u>Sponsor</u>

##### C. CONTINUING PROJECTS—INDIVIDUAL

<u>Begin/end Dates</u>	<u>Total Award</u>	<u>Your 11-12 Portion</u>	<u>Reporting Center</u>	<u>Sponsor</u>

##### D. CONTINUING PROJECTS—JOINT

<u>Begin/end Dates</u>	<u>Total Award</u>	<u>Your 11-12 Portion</u>	<u>Reporting Center</u>	<u>Sponsor</u>

#### E. DESCRIPTION OF CURRENT SPONSORED RESEARCH

#### F. DESCRIPTION OF CURRENT UNSPONSORED/DEPARTMENTAL RESEARCH

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#### Part 5: Professional Development

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##### A. Short Course

##### B. Workshop

##### C. Conference

1. Invited panel chair for Institute of Navigation GNSS conference, September 2011: GNSS Security
2. Invited session chair for IEEE/ION PLANS conference, April 2012: Receiver and Antenna Technology Session
3. Invited to testify before U.S. House Subcommittee on Homeland Security Oversight, July 2012
4. Invited session chair for Institute of Navigation GNSS conference, September 2012: Spectrum Interference Session

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## Part 6: Engineering Recognition

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### A. AWARDS & HONORS

1. Best Overall Paper Award (as co-author), IEEE/ION PLANS Conference, 2012
2. Best Student Paper Award (as co-author), IEEE/ION PLANS Conference, 2012
3. University of Texas System Regents' Outstanding Teaching Award, 2012

### B. LISTINGS

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## Part 7: Professional Community Service

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## Part 8: Professional Experience

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### A. PROFESSIONAL REGISTRATION

Current:

### B. CONSULTING

## Faculty Activity Report for Todd E Humphreys - 2012-13 - Submitted

### General Information

#### Personal Website

No Personal Website information on record for this Faculty Activity Report.

#### Biography

No Biography information on record for this Faculty Activity Report.

#### Degrees

Source	Year	Degree	Equivalency	Discipline	Institution
Central	2008	PhD	Doctoral	Aerospace Engineering	Cornell University
Central	2003	MS	Masters	Electrical, Electronics and Communications Engineering	Utah State University
Central	2000	BS	Bachelors	Electrical, Electronics and Communications Engineering	Utah State University

### Teaching

#### Teaching Comments or Statement

No Teaching Comments or Statement information on record for this Faculty Activity Report.

#### Scheduled Teaching

Source	Semester	Course Abbreviation	Course Title	Course Level	Unique Nbr	Enrollment	Credit Hours
Central	Fall 2012	ASE 372N	Satellite-Based Navigation	Undergraduate	13530	16	3
Central	Fall 2012	ASE 697K	4-Rsch In Orbital Mechanics	Graduate	13730	1	6
Central	Fall 2012	ASE 698B	Thesis	Graduate	13745	1	3
Central	Fall 2012	E E 297C	Research Problems	Graduate	17220	1	2
Central	Fall 2012	E E 397C	Research Problems	Graduate	17225	1	3
Central	Fall 2012	E E 697C	Research Problems	Graduate	17230	1	6
Central	Fall 2012	E E 997C	Research Problems	Graduate	17235	1	9
Central	Spring 2013	ASE 389P	7-Global Positioning System	Graduate	13530	5	3
Central	Spring 2013	ASE 397K	4-Rsch In Orbital Mechanics	Graduate	13590	1	3
Central	Spring 2013	ASE 698B	Thesis	Graduate	13630	1	3
Central	Spring 2013	E E 297C	Research Problems	Graduate	17045	1	2
Central	Spring 2013	E E 397C	Research Problems	Graduate	17050	1	3
Central	Spring 2013	E E 397C	Research Problems	Graduate	17050	1	3
Central	Spring 2013	E E 997C	Research Problems	Graduate	17060	1	9
Central	Spring 2013	E E 999W	Dissertation	Graduate	17165	1	9
Central	Summer 2013	ASE W397K	3-Rsch In Guidance And Control	Graduate	76240	1	3
Central	Summer 2013	ASE W399R	Dissertation	Graduate	76275	1	3
Central	Summer 2013	E E W397C	Research Problems	Graduate	77545	1	3
Central	Summer 2013	E E W397C	Research Problems	Graduate	77545	1	3

Source	Semester	Course Abbreviation	Course Title	Course Level	Unique Nbr	Enrollment	Credit Hours
Central	Summer 2013	E E W399R	Dissertation	Graduate	77620	1	3
Central	Summer 2013	E E W399W	Dissertation	Graduate	77635	1	3

**Graduate Student Supervision**

Source	Begin Semester	End Semester	Committee Role	Committee Level	Student Name	Degree Program
Central	Fall 2008	Fall 2012	Member	Doctoral	Smith, Noah Harold	Unknown
Central	Fall 2009	Fall 2013	Member	Doctoral	Munoz, Sebastian	Unknown
Central	Spring 2011	Spring 2013	Member	Doctoral	Appaiah, Kumar	Electrical and Computer Engineering
Central	Summer 2011	Fall 2013	Member	Doctoral	Bhargava, Vidur	Electrical and Computer Engineering
Central	Fall 2011	Fall 2013	Member	Doctoral	Hussein Hassan, Ehab M.	Physics
Central	Spring 2012	Fall 2013	Member	Doctoral	Mortazavi, Yousof	Electrical and Computer Engineering
Central	Summer 2012	Fall 2012	Chair	Masters	Bright, Marlon Wayne	Unknown
Central	Fall 2012	Summer 2013	Member	Doctoral	Jones, Drew Ryan	Unknown
Central	Fall 2012	Fall 2013	Co-Chair	Doctoral	Kassas, Zaher	Electrical and Computer Engineering
Central	Fall 2012	Fall 2013	Member	Doctoral	Ko, Jaegan	Electrical and Computer Engineering

**Graduate or Undergraduate Student Advising**

No Graduate or Undergraduate Student Advising information on record for this Faculty Activity Report.

**Graduate or Undergraduate Student Research**

No Graduate or Undergraduate Student Research information on record for this Faculty Activity Report.

**Scholarly & Creative Works****Current Scholarly, Creative Works, or Research Interests**

No Current Scholarly, Creative Works, or Research Interests information on record for this Faculty Activity Report.

**Publications & Creative Works**

Source	Year	Type	Description	Peer Reviewed
Faculty	None	Publication	Humphreys, T. E., and Campbell, M. E., "Disturbance and Performance Modeling," in High Performance Structures: Dynamics and Control, E. F. Crawley and M. E. Campbell, to appear.	No

**Presentations and Lectures**

No Presentations or Lectures information on record for this Faculty Activity Report.

**Intellectual Property**

No Intellectual Property information on record for this Faculty Activity Report.

## Funded Research

### Sponsored Research

Source	Begin Date	End Date	Sponsor Name	Project Title	Role	Total Award Amount	Project FY Expenditures	Investigator FY Expenditures	Percent Contribution	OSP Nbr
Central	2003-01-01	2016-12-31	Crown Castle International Corp	Wireless Networking & Communications Group (Wnccg)	Co-PI	\$4,247,264	\$13,760	\$1,720	12.50%	200201535
Central	2010-11-19	2011-01-31	Lockheed Martin Corp	Foton Sensor Development	PI	\$69,000	\$11,575	\$11,575	100.00%	201003102
Central	2011-05-01	2016-12-31	Various Donors-Industrial Sources	Wireless Internet Center For Advanced Technologies (Wicat)	Co-PI	\$725,000	\$292,702	\$16,277	33.33%	201101376
Central	2011-11-28	2012-01-16	Northrop Grumman	Gps Timing Proof Of Concept Special Studies	PI	\$65,050	\$45,085	\$45,085	100.00%	201103177
Central	2012-07-01	2012-11-15	Sandia Natl Labs	Gps Vulnerability Simulation Support	PI	\$40,113	\$2,799	\$2,799	100.00%	201201541
Central	2012-09-01	2014-01-15	Harris Corp	Research In Unmanned Aerial System Navigation System Robustness	PI	\$75,000	\$72,357	\$72,357	100.00%	201202629
Central	2013-03-25	2014-05-25	Coherent Navigation, Inc	Emitter Locator (Emloc) System For Emitter Detection And Localization - Phase Ii	PI	\$99,953	\$71,098	\$71,098	100.00%	201201563
Central	2013-06-01	2013-10-31	Northrop Grumman	Gps Security Research And Development	PI	\$75,000	\$25,515	\$25,515	100.00%	201203418

### Other Research

No Other Research information on record for this Faculty Activity Report.

## Service & Activities

No Service and Activities information on record for this Faculty Activity Report.

## Honors & Awards

No Honors and Awards information on record for this Faculty Activity Report.

### Supplemental Documents

No Supplemental Documents information on record for this Faculty Activity Report.

### General Comments

No General Comments information on record for this Faculty Activity Report.

[Return Report to Faculty](#)

**Faculty Annual Report for Year End August 31, 2014**

**Todd Humphreys**  
**Assistant Professor**  
**Aerospace Engineering and Engineering Mechanics Department**

Signature: Todd Humphreys 8/25/14

**Part 1: Teaching Activities****A. COURSES TAUGHT****Organized Classes**

SEMESTER TAUGHT	COURSE NO.	COURSE NAME	NO. SECTIONS/STUDENTS
Fall 2013	ASE 372N	Satellite-Based Navigation	1 16
Spring 2014	ASE 381P	Stoch Detection, Estimation, & Control	1 11

**Individual Instructions**

SEMESTER TAUGHT	COURSE NO.	COURSE NAME	NO. SECTIONS/STUDENTS
Fall 2013	ASE 397K	4-Research in Orbital Mechanics	1 1
Fall 2013	ASE 399W	Dissertation	1 1
Spring 2014	ASE 679HA	Undergraduate Honors Thesis	1 1
Spring 2014	ASE 697K	Research in Orbital Mechanics	1 1
Spring 2014	ASE 699W	Dissertation	1 1
Summer 2014	ASE 397K	4-Research in Orbital Mechanics	1 1

**B. GRADUATE STUDENT RESEARCH****Supervisor, PhD Dissertations**

STUDENT	DEPARTMENT	GRAD. DATE	AREA
Jashan Bhatti	ASE/EM	Spring 2015 (expected)	Orbits
Daniel Shepard	ASE/EM	Spring 2016 (expected)	Orbits
Andrew Kerns	ECE	Spring 2017 (expected)	ComNetS

**Supervisor, MS Theses/Reports**

STUDENT	DEPARTMENT	GRAD. DATE	AREA
Nathan Green	ECE	Spring 2016 (expected)	ComNetS
Andrew Kerns	ECE	Spring 2015 (expected)	ComNetS

**Co-Supervisor, PhD Dissertations**

STUDENT	DEPARTMENT	GRAD. DATE	AREA
Kyle Wesson	ECE	Spring 2014	ComNetS
Zaher Kassas	ECE	Spring 2014	ComNetS

Ken Pesyna	ECE	Spring 2015 (expected)	ComNetS
<b>Co-Supervisor, MS Theses/Reports</b>			
STUDENT	DEPARTMENT	GRAD DATE	AREA
Andrew Joplin	ASE/EM	Spring 2012	Orbits
Marlon Bright	ASE/EM	Spring 2012	Orbits
<b>Member PhD Committees</b>			
STUDENT	DEPARTMENT	GRAD DATE	AREA
Jasgan Ko	ECE	Spring 2013	ComNetS
Kumar Appaiah	ECE	Spring 2012	ComNetS
Vidur Bhargava	ECE	Spring 2012	ComNetS
Kien Trung Truong	ECE	Spring 2011	ComNetS
Thomas Novlan	ECE	Spring 2012	ComNetS
Drew Jones	ASE/EM	Spring 2013	Orbits
Jing Lin	ECE	Fall 2012	ComNetS
Chao Jia	ECE	Fall 2013	ComNetS
Yezhou Wang	ECE	Spring 2013	ComNetS
Noah Smith	ASE/EM	Spring 2013	Orbits
Ehab Hussein Hassan	Physics	Spring 2015 (expected)	Physics

<b>Reader, MS Committees</b>			
STUDENT	DEPARTMENT	GRAD DATE	AREA
Constance McDaniel Wyman	ASE/EM	Fall 2014	Orbits

## C. OTHER RESEARCH SUPERVISION

### Other Categories

#### UNDERGRADUATE HONORS PROJECTS

Daniel Shepard  
Shubhodeep Mukherji

## D. ADDITIONAL TEACHING ACTIVITIES

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### Part 2: Administrative And Committee Assignments

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#### A. ADMINISTRATIVE COMMITTEES

Director, Radionavigation Laboratory, 2009-present  
Faculty advisor for student chapter of AIAA, 2010-present

#### B. UNIVERSITY COMMITTEES

##### University

College  
Cockrell School Honors Committee, 2011-present  
College of Engineering Faculty Committee  
ECE Graduate Studies Committee

**Department**  
Orbits Area Faculty Committee  
Graduate Studies Committee

## C. OUTSIDE COMMITTEES

### International

#### National

Member, American Institute of Aeronautics and Astronautics (AIAA)  
Member, Institute of Electrical and Electronics Engineers (IEEE)  
Member, Institute of Navigation

#### State

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### Part 3: Contributions to Technology

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#### A. REFEREED ARCHIVAL JOURNALS

1. Psiaki, M.L., B.W. O'Hanlon, J.A. Bhatti, D.P. Shepard, and T.E. Humphreys, "GPS Spoofing Detection via Dual-Receiver Correlation of Military Signals," *IEEE Transactions on Aerospace and Electronic Systems* vol. 49, no. 4, pp. 2250-2267, 2013.
2. Kassas, Z. M. and Humphreys, T. E., "Observability Analysis of Collaborative Opportunistic Navigation with Pseudorange Measurements," *IEEE Transactions on Intelligent Transportation Systems*, 2013, vol. 15, pp. 260-273, Feb. 2014.
3. Pesyna, K.M., Z.M. Kassas, R.W. Heath, and T.E. Humphreys, "A Phase-Reconstruction Technique for Low-Power Centimeter-Accurate Mobile Positioning," *IEEE Transactions on Signal Processing*, 2013, May 2014.
4. Kerns, A. J., D. P. Shepard, J. A. Bhatti, and T. E. Humphreys, "Unmanned aircraft capture and control via GPS spoofing," *Journal of Field Robotics* vol. 31, no. 4, pp. 617-636, 2014.
5. O'Hanlon, B.W., M. L. Psiaki, T. E. Humphreys, J. A. Bhatti, and D. P. Shepard, "Real-time GPS spoofing detection via correlation of encrypted signals," *NAVIGATION, Journal of the Institute of Navigation*, 201, vol. 60, no. 4, pp. 267-278, 2013.
6. Lightsey, G., T. E. Humphreys, J. A. Bhatti, A. J. Joplin, B. W. O'Hanlon, and S. P. Powell, "Demonstration of a Space Capable Miniature Dual-Frequency GNSS Receiver," *NAVIGATION, Journal of the Institute of Navigation*, 2013, vol. 61, no. 1, pp. 53-64, 2014.
7. Z. M. Kassas and T. E. Humphreys, "Observability analysis of collaborative opportunistic navigation with pseudorange measurements," *IEEE Transactions on Intelligent Transportation Systems*, vol. 15, pp. 260-273, Feb. 2014.
8. H. Kim, C. Clauer, K. Deshpande, M. Lessard, A. Weatherwax, G. S. Bust, G. Crowley, and T. E. Humphreys, "Ionospheric irregularities during a substorm event: Observations of ULF pulsations and GPS scintillations," *Journal of Atmospheric and Solar-Terrestrial Physics*, vol. 114, pp. 1-8, 2014.
9. Z. M. Kassas, A. Arapostathis, and T. E. Humphreys, "Greedy motion planning for simultaneous signal landscape mapping and receiver localization," *IEEE Journal of Selected Topics in Signal Processing*, 2014. (In preparation after favorable reviews.)
10. Z. M. Kassas and T. E. Humphreys, "Receding horizon trajectory optimization in opportunistic navigation environments," *IEEE Transactions on Aerospace and Electronic Systems*, 2014. (In preparation after favorable reviews.)
11. C. R. Clauer, H. Kim, K. Deshpande, Z. Xu, D. Weimer, S. Musko, G. Crowley, C. Fish, R. Nealy, T. E. Humphreys, J. A. Bhatti, and A. J. Ridley, "Autonomous adaptive low-power instrument platform (AAL-PIP) for remote high latitude geospace data collection," *Geoscientific Instrumentation, Methods and Data Systems*, 2014. (In preparation after favorable reviews.)

**B. REFEREED CONFERENCE PROCEEDINGS**

1. K. M. Posyna Jr., R. W. Heath Jr., and T. E. Humphreys, "Precision limits of low-energy GNSS receivers," in Proceedings of the ION GNSS+ Meeting, (Nashville, Tennessee), Institute of Navigation, 2013.
2. Z. Kassas, J. A. Bhatti, and T. E. Humphreys, "Receding horizon trajectory optimization for simultaneous signal landscape mapping and receiver localization," in Proceedings of the ION GNSS+ Meeting, September 2013.
3. Z. Kassas and T. E. Humphreys, "The price of anarchy in active signal landscape map building," in Proceedings of IEEE Global Conference on Signal and Information Processing, December 2013.
4. Z. M. Kassas, J. A. Bhatti, and T. E. Humphreys, "A graphical approach to GPS software-defined receiver implementation," in Proceedings of IEEE Global Conference on Signal and Information Processing, December 2013.
5. K. D. Wesson, B. L. Evans, and T. E. Humphreys, "A combined symmetric difference and power monitoring GNSS anti-spoofing technique," in IEEE Global Conference on Signal and Information Processing, 2013.
6. K. D. Wesson, B. L. Evans, and T. E. Humphreys, "A probabilistic framework for Global Navigation Satellite System signal timing assurance," in Proceedings of Asilomar Conference on Signals, Systems, and Computers, (Pacific Grove, CA), 2013.
7. A. J. Kerns, K. D. Wesson, and T. E. Humphreys, "A blueprint for civil GPS navigation message authentication," in Proceedings of the IEEE/ION PLANS Meeting, May 2014.
8. D. P. Shepard and T. E. Humphreys, "High-precision globally-referenced position and attitude via a fusion of visual SLAM, carrier-phase-based GPS, and inertial measurements," in Proceedings of the IEEE/ION PLANS Meeting, May 2014.
9. T. E. Humphreys, D. P. Shepard, J. A. Bhatti, and K. D. Wesson, "A testbed for developing and evaluating GNSS signal authentication techniques," in Proceedings of the International Symposium on Certification of GNSS Systems and Services (CERGAL), (Dresden, Germany), July 2014. (Available at <http://radionavlab.ae.utexas.edu/testbed>)

**C. NON-REFEREED PAPERS**

K. D. Wesson and T. E. Humphreys, "Hacking drones," Scientific American, vol. 309, no. 5, pp. 54–59, 2013.

**D. BOOKS AUTHORED/CO-AUTHORED**

**E. BOOKS EDITED/CO-EDITED**

**F. BOOKS CHAPTERS**

T. E. Humphreys, The GNSS Handbook, ch. Interference. Springer, 2014. (in preparation).

**G. BOUND TECHNICAL REPORTS**

**H. ORAL PRESENTATIONS**

1. Humphreys, T. E., "Maritime Navigation Security," (invited) International Hydro-graphic Organization & Professional Yachters Association Sea Changes Seminar, Monaco. September 26, 2013.
2. Humphreys, T. E., "Secure PNT for Autonomous Systems," (invited) Stanford PNT Symposium, Stanford University, Stanford, CA. November 14, 2013.
3. Humphreys, T. E., "Location Deception," (invited) SXSW Interactive, Austin, TX. Audio available at <https://soundcloud.com/officialsxsw/location-deception-yacht-vs>. March 7, 2014.
4. Humphreys, T. E., "Secure Perception for Autonomous Systems, (invited keynote presentation) Cornell Sibley Graduate Research Symposium, Ithaca, NY. March 6, 2014.
5. Humphreys, T. E., "Secure Perception for Autonomous Systems," (invited) University of Illinois at Urbana-Champaign, Urbana, IL. Slides available at <http://tinyurl.com/onksode>. O3 March 6, 2014.
6. Humphreys, T. E., "Secure Perception for Autonomous Systems," (invited) University of Texas Student Engineering Council Symposium, Austin, TX. April 15, 2014.

**I. PATENTS**

D. Shepard, T. E. Humphreys, K. Pesyna, and J. Bhatti, "A system and method for using global navigation satellite system (GNSS) navigation and visual navigation to recover absolute position and attitude without any prior association of visual features with known coordinates," Feb. 2014. US Patent filed on Feb., 3, 2014.

**J. COPYRIGHTED SOFTWARE****Part 4: Research Activities/Grants & Contracts****A. PROJECTS FUNDED-INDIVIDUAL**

<u>Begin/end Dates</u>	<u>Total Award</u>	<u>Your Portion</u>	<u>Reporting Center</u>	<u>Sponsor</u>
1/2014 – 1/2015	\$100,000	\$100,000		Samsung Research America
<u>Project Title</u>	"Precise positioning for mobile devices"			
<u>Begin/end Dates</u>	<u>Total Award</u>	<u>Your Portion</u>	<u>Reporting Center</u>	<u>Sponsor</u>
6/2013 – 6/2014	\$23,000	\$23,000		UT Wireless Networking and Communications Group
<u>Project Title</u>	"Communication and Location Research"			
<u>Begin/end Dates</u>	<u>Total Award</u>	<u>Your Portion</u>	<u>Reporting Center</u>	<u>Sponsor</u>
6/2013 – 6/2015	\$120,000	\$120,000		U.S. Air Force GPS Directorate, NAVSEA/NGA
<u>Project Title</u>	"Strengthening GPS Receiver Resistance to Deceptive Civil Signals"			
<u>Begin/end Dates</u>	<u>Total Award</u>	<u>Your Portion</u>	<u>Reporting Center</u>	<u>Sponsor</u>
6/2013 – 4/2014	\$150,000	\$150,000		U.S. Defense Threat Reduction Agency via Northrop Grumman Corp
<u>Project Title</u>	"GPS Timing Phase II Proof of Concept"			
<u>Begin/end Dates</u>	<u>Total Award</u>	<u>Your Portion</u>	<u>Reporting Center</u>	<u>Sponsor</u>
4/2013 – 4/2015	\$225,016	\$225,016		U.S. Navy via Coherent Navigation
<u>Project Title</u>	"Emitter locator (EMLOC) system for emitter detection and localization—Phase II"			
<u>Begin/end Dates</u>	<u>Total Award</u>	<u>Your Portion</u>	<u>Reporting Center</u>	<u>Sponsor</u>
9/2012 – 12/2013	\$36,000	\$36,000		Gift funding from NSF WiCAT Center, UT Wireless Networking and Communications Group
<u>Project Title</u>	"Cooperative Opportunistic Navigation Research"			

**B. PROJECTS FUNDED-JOINT**

<u>Begin/end Dates</u>	<u>Total Award</u>	<u>Your Portion</u>	<u>Reporting Center</u>	<u>Sponsor</u>
9/13-9/17	\$2,800,000	\$132,000		U.S. Department of Transportation
<u>Project Title</u>	"Data-Supported Transportation Operations and Planning (D-STOP)"			
<u>Begin/end Dates</u>	<u>Total Award</u>	<u>Your Portion</u>	<u>Reporting Center</u>	<u>Sponsor</u>
5/2014 –	\$75,000			UT College of Natural Sciences Catalyst Grant

5/2015

Competition

Project Title : "Development of Transformative Tracking and Mapping Instrumentation for Tracking, Mapping and Identifying Camouflage and Navigation Strategies in Dynamic, Complex Environments"

**C. CONTINUING PROJECTS—INDIVIDUAL**

<u>Begin/end Dates</u>	<u>Total Award</u>	<u>Your Portion</u>	<u>Reporting Center</u>	<u>Sponsor</u>

Project Title**D. CONTINUING PROJECTS—JOINT**

<u>Begin/end Dates</u>	<u>Total Award</u>	<u>Your Portion</u>	<u>Reporting Center</u>	<u>Sponsor</u>

Project Title**E. DESCRIPTION OF CURRENT SPONSORED RESEARCH**

Optimal estimation and detection, navigation and timing security, cyber-physical systems security, Global Navigation Satellite Systems (GNSS) signal processing, GNSS-based study of the ionosphere and neutral atmosphere, GNSS integrity and security, software-defined radio.

**F. DESCRIPTION OF CURRENT UNSPONSORED/DEPARTMENTAL RESEARCH****Part 5: Professional Development****A. Short Course****B. Workshop****C. Conference**

Session chair for the IEEE/ION PLANS conference, May 2014: Interference and Robust Navigation.  
Lead organizer, 2013 Texas Wireless Summit  
Track Chair, Institute of Navigation GNSS+ Conference, September 2013.

**Part 6: Engineering Recognition****A. AWARDS & HONORS****B. LISTINGS****Part 7: Professional Community Service**

Land Representative, Institute of Navigation Governing Council, 2012-2014

**Part 8: Professional Experience****A. PROFESSIONAL REGISTRATION**

Current:

**B. CONSULTING**

### Budget Council Assessment of Teaching for Todd Humphreys

Prepared by: Leszek Demkowicz

David Goldstein

Bob Schutz

#### Principal Areas of Teaching

The principal areas of Dr. Humphreys' teaching are spacecraft dynamics and GPS-based navigation. He has taught two undergraduate classes: ASE 366K Spacecraft Dynamics (2x), ASE 372N Satellite-Based Navigation (3x), and three graduate classes: ASE 389P 7. Global Positioning System (3x), ASE 396 Model Based Detection/Estimation (1x), ASE 381P 8. Stochastic Detection, Estimation and Control (1x). The graduate classes are strongly linked with Dr. Humphreys' research.

#### Teaching Evaluation Procedures and Measures

The ASE/EM Dept. utilizes two teaching evaluation procedures: obligatory student Course/Instructor Evaluations Surveys, and peer evaluation by budget council members. Student evaluations are conducted at the end of each semester and peer evaluations are done annually. The evaluating faculty attend a whole lecture, frequently w/o a prior warning of the lecturer. The person being evaluated receives the evaluations and has a chance to discuss them with the chairman of the dept.

#### Summary of Student Teaching Evaluations

Dr. Humphreys has been buying out one class per year teaching one class per semester. He taught two undergraduate and 3 graduate classes. Table 1 shows the results of Course/Instructor Survey ratings for all classes taught by Dr. Humphreys. All ratings, for both the instructor and course, are consistently very high and exceed college and departmental averages.

**Table 1. Summary of Student Evaluations**

Number	Course Name	Semester	# students	Instructor	Course
ASE 366K	Spacecraft dynamics	Fall 09	78	4.8	4.3
ASE 389P	7. Global Positioning Systems	Spring 10	11	4.9	4.8
ASE 366K	Spacecraft dynamics	Fall 10	78	4.6	4.5
ASE	Undergraduate Honor	Spring 11	1	5	5

679HB	Thesis				
ASE 398R	Master's Report	Spring 11	1	1	1
ASE 372N	Satellite Based Navigation	Fall 11	14	4.7	4.9
ASE 396	Model-Based Detection/Estimation	Spring 12	24	4.7	4.6
ASE 372N	Satellite-Based Navigation	Fall 12	16	4.6	4.4
ASE 389P	7. Global Positioning Systems	Spring 13	5	4.8	4.5
ASE 372N	Satellite Based Navigation	Fall 13	16	5	4.7
ASE 381P	8. Stochastic Detection, Estimation and Control	Spring 14	12	4.8	4.6

In comparison to other faculty who have taught the same courses over the past three years, Dr. Humphrey's scores are higher in every course, as exemplified by the data in Table 2.

**Table 2. CIS Comparisons**

Instructor	Year	Semester	Course	Enrolled	Instructor	Course
Humphreys	2011/12	Spring	ASE 396	24	4.7	4.6
Humphreys	2009/10	Spring	ASE 389P	11	4.9	4.8
Humphreys	2012/13	Spring	ASE 389P	5	4.8	4.5
Humphreys	2010/11	Spring	ASE 389P	7	4.6	4.8
Humphreys	2013/14	Spring	ASE 381P	12	4.8	4.6
Marchand	2010/11	Spring	ASE 381P	2	4	4
Humphreys	2013/14	Fall	ASE 372N	16	5	4.7
Humphreys	2011/12	Fall	ASE 372N	14	4.7	4.9
Humphreys	2012/13	Fall	ASE 372N	16	4.6	4.4
Harris	2010/11	Fall	ASE 372N	21	3.5	3.5
Humphreys	2009/10	Fall	ASE 366K	67	4.8	4.3
Humphreys	2010/11	Fall	ASE 366K	75	4.6	4.5
Magruder	2011/12	Fall	ASE 366K	80	4.1	3.9
Magruder	2010/11	Spring	ASE 366K	54	4.1	4

Russell	2012/13	Fall	ASE 366K	40	3.5	3.6
Nagel	2013/14	Fall	ASE 366K	78	3.1	3.4
Nagel	2012/13	Spring	ASE 366K	64	3	3.1
Russell	2011/12	Spring	ASE 366K	49	2.9	2.8

The high evaluations scores are confirmed by a large number of very favorable students' comments that can be found in the evaluation materials. Enclosed below are a few sample comments offered by students.

``You are a great professor – best one I had this semester"...

`` I enjoyed the anecdotes and historical information added to the equations – I liked how it established a better context..."

``As a class, it was probably the most interesting subject I have taken. As an instructor, I felt the way you presented the information, kept the lecture form being dull.."

``Great job! ... I really liked your enthusiasm for the class and this subject! It's contagious."

``This has been one of my favorite classes so far, and you are definitely one of the best professors, I have ever had at UT..."

`` Excellent course taught be an excellent professor. In-class participation was made really easy and fun..."

`` I liked the way you taught the course. It was awesome! Now I feel like majoring in space even more..."

`` Professor. You did a good job! A++ Perfection is never achieved but you were close!"

`` You were the best professor I have had and you motivated me to pursue a degree in space design..."

`` ...it was the most interesting subject I have taken.."

`` ...look forward to possibly taking more classes with you in the future..."

### **Summary of Peer Evaluations**

The faculty colleagues who performed the peer evaluations are listed in Table 3. Each reviewer is a full professor, and the evaluations have covered all courses taught by Dr. Humphreys.

**Table 3. Peer Evaluation Reports**

Number	Course Name	Semester	Evaluator
ASE 366K	Spacecraft dynamics	Fall 09	Hans Mark
ASE 389P	7. Global Positioning Systems	Spring 11	Clint Dawson
ASE 372N	Satellite Based Navigation	Fall 11	Wallace Fowler
ASE 389P	7. Global Positioning Systems	Spring 13	David Goldstein
ASE 372N	Satellite Based Navigation	Fall 13	Philip L. Varghese
ASE 381P	8. Stochastic Detection, Estimation and Control	Spring 14	Thomas J.R. Hughes

All evaluations have been very positive and some enthusiastic. Selected comments are listed below.

"His interaction with the students was good and he knows the first names of a number of students when calls them for answers." (Mark)

"Dr. Humphreys has a good rapport with the students. He engaged them in the lecture..." (Dawson)

"Dr. Humphreys is a master of the course material and very much at home in the classroom." (Fowler)

" His lecture and discussion style were excellent and the high grades he receives from the students ... are well deserved." (Goldstein)

`` He has an engaging classroom presence and it is clear that the students enjoy his presentation style."(Varghese)

``Professor Humphreys has an engaging personality and is a charismatic teacher... I have been teaching for over 40 years and I think I learned a few things today..." (Hughes)

Two conclusions are transparent from the peer evaluations. First, Dr. Humphreys is an exceptional teacher with a rare talent to engage students and share his research experience. Secondly, his peer evaluations are increasingly more enthusiastic with time, demonstrating a continued effort for a further improvement.

### **Comments on Teaching From Solicited and Unsolicited Evaluation Letters**

To complete the picture, we cite a few comments extracted from the solicited and unsolicited review letters.

`` Todd has established a very strong bridge between our departments and is the linchpin behind several high visibility and very effective collaborative projects and efforts between the two departments. The graduate courses that Todd teaches on statistical estimation theory and stochastic detection, estimation, and control are regularly attended by our graduate students, including my own students, and complement courses offered in our department." (Tewfik, chairman of EE at UT Austin)

`` Prof. Humphreys ... has been very effective at graduate student advising and mentoring, as evident by awards they have received while under his supervision." (Kamalabadi, U Illinois at Urbana-Champaign)

`` I am also quite impressed with his very recent work in collaboration with his PhD student Z.M. Kassas on opportunistic navigation." (Axelrad, U Colorado at Boulder)

``... an excellent teacher..."(Young, JPL)

`` His graduate students' presentations at conferences are always prepared to the highest standards." (Pervan, Illinois IT)

`` His online lecture on *How to Fool a GPS* is highly successful and instrumental in promoting awareness of spoofing threats to GPS." (Lachapelle, U Calgary)

`` ...it is commendable that the candidate has advised two Ph.D. students to completion, one of whom has earned a faculty position, prior to being evaluated for promotion to Associate Professor." (Farrell, U California, Riverside)

### **Balance Between Undergraduate and Graduate Teaching**

Due to the intensity of his research, Dr. Humphreys has taught fewer classes than an average assistant professor at this stage of career. The classes that he has taught though represent a good balance between undergraduate and graduate teaching and students from both groups are equally enthusiastic about his style of teaching.

### **Contributions to Teaching Portfolio, Innovative Contributions**

Dr. Humphreys contributes items to his teaching portfolio which is maintained by the department. These include copies of syllabi, homework assignments, labs instructions, copies of some hand-written lecture notes, sample project write-ups, PP presentations, and copies of past exams. It is really fun to review some of the materials! Without giving up the traditional values of a well-organized blackboard lecture (see peer evaluations), Dr. Humphreys wonderfully connects with numerous web pages utilizing simulators and materials collected by professional colleagues.

### **Students Research Advising**

Dr. Humphreys was the primary supervisor of two graduated Ph.D. Students: Z.M. Kassas, now Assistant Professor at EE Dept., U California, Riverside, and K. Wesson, now with Zeta Associates. He has also co-supervised two master theses and participated in 10 Ph.D. Committees. He currently supervises five Ph.D. Students of which three have been admitted to candidacy. He also supervised two undergraduate honors projects. It is remarkable that one of his students is already an Assistant Professor himself.

### **Summary**

Without any doubt, Dr. Humphreys' teaching and supervising have been exemplary. The vast majority of students' comments are very positive and many are simply enthusiastic. Many students regard him to be the best UT professor they have had. And all of this happens despite evidently very demanding exams and homework load. It is not a coincidence that in August 2012, Dr. Humphreys was awarded the Regents' teaching award – the most prestigious award offered by the UT system. Later the same year, he was recognized by the Dean of the Cockrell School with an award for outstanding teaching by an assistant professor.

## STATEMENT ON TEACHING

TODD HUMPHREYS

I enjoy teaching and am committed to it. In August 2012 I was awarded the Regents' teaching award—the most prestigious teaching award offered throughout the University of Texas system. Later that year I was recognized with the Cockrell School dean's award for outstanding teaching by an assistant professor.

I'll convey my teaching philosophy through a collection of advice such as I would share with a first-year assistant professor. My teaching portfolio can be found here.

### A PRIME DIRECTIVE: DON'T BORE THE STUDENTS

My teaching philosophy flows from this one maxim: Don't bore the students. If the lecture lacks luster, attendance and enthusiasm drop, and a moribund feeling sets in. Most of us have a vague goal of "making lectures interesting," yet we're notoriously bad at it, as any undergraduate will testify. Students understand that we've got obligations besides teaching. When they plead for more verve in the classroom, they're not necessarily asking us to devote more time, but rather to more effectively use the time we already devote. Subsequent sections on listening, memorable illustrations, puzzlement, and research-infused teaching will treat the "do's"; here I'll discuss the "don't's," or paths to boredom.

**Lack of Context.** Suppose your topic is the structure of a GPS signal. You lay out a model for the signal in the form of an equation for the received samples, pedantically labeling each of the components. The equation includes all the important parts and their mutual relationships. It's all the students really *need* to know to work with the signal. But the students won't find the signal structure *memorable* or *interesting* because it's been offered without context.

The same presentation of the signal structure can be made much livelier with some stage-setting: "As it turns out, the early designers of the GPS signals agonized over the choice of broadcast frequency: too low and the signals would be absorbed by the ionosphere; too high and they wouldn't penetrate even tree leaves. There was also debate about how to provide multiple access. Fortunately, the US settled on code-division; the Soviets, who were slavishly copying the GPS system in all other respects, made the fateful decision to adopt frequency division. They're still regretting that today, as I'll explain later." One then launches into the GPS signal structure model, tying components as appropriate to the drama of their development. Adding context extends the discussion by perhaps an extra five minutes, but these are minutes well spent. The students now understand that the current signal structure isn't the only way things

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*Date:* August 13, 2014.

could have turned out; they're more aware of the engineering decisions that had to be made; and they feel empowered to question other aspects of the signal structure.

**Obviousness.** The information content of a classroom discussion is inversely proportional to the obviousness of statements made. An exposition can be clear without being obvious. Boredom-inducing obviousness is most likely found in the way we phrase our questions. It's fine to toss out a few matter-of-fact questions (e.g., "How many constants of the motion are required for solution of the 3-body problem?") just to see whether students are following along, but the real novelty—and learning—comes by asking clear but puzzling questions.

**Enthusiasm without Substance.** Enlivening the classroom experience is not simply a matter of smiling more, moving about, modulating one's voice, and clapping one's hands together for dramatic effect. Students are looking for purposeful enthusiasm—enthusiasm that values, not wastes, their time. The anecdotes we add to lecture must be an enhancement of, and not a substitute for, a rigorous technical discussion.

#### THE SECRET TO CLASSROOM BUZZ: LISTEN TO, AND PLAY OFF, STUDENTS' QUESTIONS

It's not practical to think of the classroom experience as one long exciting conversation with the professor acting merely as a discussion facilitator. Students internalize concepts well in this kind of discovery learning environment, but they internalize altogether too few concepts. There is a great deal of material to be mastered in engineering! On the other hand, students learn best when they participate. The art of teaching involves knowing how to strike the right balance between covering more material and eliciting more student participation in the learning process: It's a classical tradeoff of educational breadth versus potency.

My approach to this tradeoff is to intersperse a fairly traditional lecture with two or three intense question-and-answer segments. Sometimes I'll begin the questioning; sometimes it's the students who start off. If successful, these brief back-and-forth interludes set the classroom abuzz. Success depends on getting students to ask meaningful questions, and this, I've found, depends on my paying close attention to their earlier questions and proving to them that I've done so.

Most students want to participate—they find it enjoyable and they know it helps them learn. But they'll see no point in participating if the professor brushes off their questions with a cursory response or is clearly preoccupied with other thoughts as they're speaking. I try to follow these "R's" when a student asks a non-trivial question: **R**ecognize the student by name (easy for small classes; harder for large classes). **R**estate the question in my own words. **R**eformulate, **R**edirect, or **R**espond: Reformulate the question in a way that the student recognizes the answer (best outcome); or redirect the question to the rest of the class (next best, time permitting); or respond directly (least effective technique, but often appropriate). **R**iff off of the question to emphasize a point or make a transition into the next stage of the lecture. **R**efer back to the question if something later in the same lecture offers further clarification. **R**efer back to the question in *later lectures* if it was particularly insightful.

I can't overemphasize the potency of these "R's" in engaging students and thereby deepening each student's understanding of the concepts presented. If the secret to learning is participation, the secret to participation is making students feel smart and insightful when they open their mouths.

### PUZZLE, ENLIGHTEN, REPEAT

During my undergraduate years I turned a childhood fascination with magic into a part-time job, performing magic shows at children's birthday parties and school functions. Much of my teaching style is adapted from my years as a children's magician.

The attraction of stage magic depends on one's maturity. Younger children are captivated by the wonder and humor of surprising outcomes; older children can't rest until they've figured out how it's done. Puzzlement is a powerful—and fairly universal—impetus to learning. Confronted with our own ignorance in the face of a simply-stated paradox, we probe a thousand directions in our mind, reasoning out constraints along the way that winnow the possibilities. This is the deepest kind of problem solving; a puzzle is at once a test and an exercise of learning. The payoff is a satisfying sense of wonder and relief when the breakthrough comes. The tension of puzzlement and the release of enlightenment makes puzzle-solving or paradox-resolving genuinely enjoyable.

My lectures are often structured around paradoxes. After introducing the context, I commonly lead into a new topic with a puzzling question or series of questions, which I write down completely on the board. For puzzling questions that are to be resolved during lecture, I either (1) solicit a response from volunteers across the whole class, (2) call on a student by name, or (3) ask the students to pair up and discuss the puzzle for about a minute, after which I call on one group to give us their insights.

Like a good magic trick, the simpler the puzzle and the cleaner the presentation, the more captivating. Puzzling questions don't necessarily have to be paradoxical or tricky. The hallmark of a puzzling question is that it pushes us to think beyond the immediate constraints that we've been presented with, extrapolating to other logical constraints, and thereby identify a family of plausible answers. Here are some examples drawn from my lecture notes:

- Q:** Why are there only 8 planets in our solar system; no more, no less? (This question, from my undergraduate Spacecraft Dynamics course, is meant to connect students with Johannes Kepler's way of thinking. He saw deep metaphysical meaning in the number of known planets—5 in his day.)
- Q:** If we have Newton's three laws of motion and his gravitational law, do we also need Kepler's laws to solve the two-body problem? (Also from my undergraduate Spacecraft Dynamics course, this question often initially gets answered "yes." But students realize upon further reflection that Kepler's laws are *embedded* in Newton's laws—Kepler's laws were the constraints by which Newton derived his laws. This leads to a discussion of mathematical parsimony.)
- Q:** From the perspective of an observer on Earth, the clocks in GPS satellite tend to run slow due to special relativity and fast due to general relativity. Could these two effects

possibly cancel out at a certain altitude? (I presented this question during lecture in my undergraduate Satellite Navigation course and offered 5 points extra credit for the first student to email me a correct response. Almost all students responded.)

#### MEMORABLE ILLUSTRATIONS

Effective teachers have a gift for memorable illustrations or analogies, from Jesus to Hume to Feynman and others more contemporary. To evoke an illustration is to tell a short story, and our brains are wired to remember stories. My students will attest that I make liberal use of far-fetched analogies in an effort to give them an indelible conceptual hook. For added effect, I often refer back to these analogies in exams.

#### OLD SCHOOL, CHALK AND NOTES

Advocates of in-class peer instruction often deride the traditional chalk-and-notes lecture format. “If you’d like to come by my office hours and have me copy my lecture notes onto the board so that you can copy them from the board into your notes,” one professor commented, “then by all means drop by. But in lecture we’ll make more effective use of our time.” This sounds convincing at first. Besides being inefficient, the chalk-and-notes approach sounds dull. Shouldn’t we instead distribute notes beforehand and devote class time to a discussion spiced with PowerPoint slides, relieving both the instructor and the students of the need to write anything in class?

I don’t think so, for the following reasons: (1) I reject the notion that a chalk-and-notes format is necessarily dull. (2) It is profoundly empowering for students to realize at semester’s end that their notebooks have become a course textbook written in their own hand. (3) PowerPoint slides can be an effective supplement to a lecture but should be used sparingly; they are otherwise soporific. (4) Students learn best when they take notes during class and review those notes often. The act of writing down what is written on the board isn’t a mindless one.

#### BACKSTAGE

A good course involves extensive “backstage” work outside the lecture hall. This includes developing quality syllabuses, assignments, and exams; offering individual or small-group interaction during office hours; maintaining the course website; and, yes, grading. I tell students who only audit my courses that they’re missing out on half the learning. I send personal emails to the top performers in the class congratulating them on their test grades, etc. Insofar as my time (and the class size) permits, I want students to know that I consider them individually and want each one to succeed.

THE UNIVERSITY OF TEXAS AT AUSTIN

*E-mail address:* todd.humphreys@mail.utexas.edu

## Candidate's Statement on Teaching

**Table 1. Teaching Summary**

Metric	Value
# of Students Taught	246
Average Instructor Evaluation UG	4.74
Average Instructor Evaluation Grad	4.76
Average Course Evaluation UG	4.56
Average Course Evaluation Grad	4.66

\*count 1 if sole advisor, 0.5 if co-advised

**Table 2. Course schedule by semester in ASE/EM since 2009; number of students indicated.**

Course	F 09	S 10	F 10	S 11	F 11	S 12	F 12	S 13	F 13	S 14
ASE 366K	67		75							
ASE 372N					14		16		16	
ASE 389P		11		7				5		
ASE 396						24				
ASE 381P										11

**Table 3. Summary of Current Graduate Students Supervised at UT-Austin**

Student	Co-Supervisor	Degree	Start Date	Date Reached Candidacy	Date Expected to Reach Candidacy	Expected Graduation Date
Jahshan Bhatti	None	Ph.D.	08/2009	04/2013		Spring 2015
Ken Pesyna	Robert Heath (ECE)	Ph.D.	08/2009	05/2014		Spring 2015
Daniel Shepard	None	PhD	09/2011		09/2014	Spring 2016
Andrew Kerns	None	PhD	09/2012		05/2016	Spring 2017
Nathan Green	None	PhD	09/2013		05/2017	Spring 2018

DEPARTMENT OF AEROSPACE ENGINEERING AND ENGINEERING MECHANICS  
THE UNIVERSITY OF TEXAS AT AUSTIN

210 E. 24<sup>th</sup> St. • WRW 401C • 1 University Station MC C0600 • Austin, Tx 78712-0235  
Tel: (512) 471-5077 • Fax (512) 471-4070

IN STRICT CONFIDENCE

*Hans Mark*  
Professor and John J. McKetta Centennial  
Energy Chair in Engineering

December 2, 2009

Chairman Philip L. Varghese  
Department of Aerospace Engineering and Engineering Mechanics  
WRW 215  
The University of Texas at Austin

Dear Chairman Varghese:

On November 24<sup>th</sup>, I audited the ASE 366K class taught by Professor Todd Humphreys. There are about fifty students in the class. Professor Humphreys was explaining space craft attitude control using the Euler angles. Here are some observations:

- 1.) He had no visual aids but made some good drawings on the white board.
- 2.) His interaction with the students was good and he knows the first names of a number of students when he calls on them for answers.
- 3.) He used lecture notes which he holds in his hand while he was writing on the white board. I noticed that he never looked at them.
- 4.) He clearly knows his stuff.

I spoke with Professor Humphreys after the class and suggested that he use more visual aids. He said that he was already doing that. I did not mention the lecture notes. I believe that he will soon come to the conclusion that he does not need them.

*Hans Mark*  
Hans Mark

*Dec. 2, 2009*

AEROSPACE ENGINEERING & ENGINEERING MECHANICS

THE UNIVERSITY OF TEXAS AT AUSTIN

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**MEMORANDUM**

**TO:** Philip Varghese, Professor and Chair  
**FROM:** Clint Dawson, Professor  
**SUBJECT:** Peer Teaching Review of Todd Humphreys, spring 2011  
**DATE:** April 25, 2011

I attended Todd Humphreys class ASE 389P.7 "Global Positioning Systems" on April 25, 2011. The class has about 8 students. Dr. Humphreys has a good rapport with the students. He engaged them in the lecture, and they responded to his questions. Being a specialized graduate topics course, the students obviously were interested in the subject matter and Dr. Humphreys is an expert in the field. I would expect that he would get high evaluations from the students in this course.

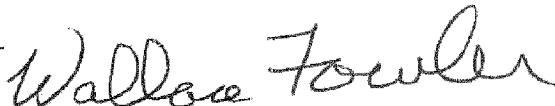
CD:bbn

*Clint Dawson*

AEROSPACE ENGINEERING & ENGINEERING MECHANICS  
THE UNIVERSITY OF TEXAS AT AUSTIN

*210 E. 24th Street, WRW • Tel. 512-471-7593 • Fax 512-471-3788  
1 University Station C0600 • Austin, Texas 78712-0235*

To: Dr. Philip Varghese, Chair  
Dept. of Aerospace Engineering and Engineering Mechanics

From: Wallace Fowler  
Professor 

Date: October 20, 2011

Subject: Peer Review of Teaching of Dr. Todd Humphreys

I visited Dr. Humphreys' ASE 372N, "Satellite Based Navigation", from 11:00 AM - 12:30 PM on Thursday, October 20, 2011. The class was held in WRW 413. There were thirteen students present in the classroom. He began the class promptly at 11 AM. I had not told him when I would be visiting so my presence was not expected.

Dr. Humphreys began class by asking his students if they had questions. His students clearly felt at ease with him and asked questions several times throughout the lecture. Dr. Humphreys handled these questions with ease, sometimes helping students to answer their own questions. At least three times during the lecture, Dr. Humphreys posed questions from past work for the class and asked them to consult with their neighbors for about 45 seconds. He would then choose someone from the class to provide the answer. If the student hesitated, he gently provided hints. Dr. Humphreys knows all of his students by name and apparently knows a lot about their individual levels of understanding of the material. His questions always seemed to be challenging to the students addressed, but not above their understanding. The students seemed quite at ease with this procedure.

Dr. Humphreys makes very efficient use of the blackboard. He uses the rightmost three panels of the board, leaving the leftmost panel open for answering student questions, drawing explanatory diagrams, etc. He filled the three rightmost panels four times during the seventy five minute class. His work at the blackboard is clear, concise, and legible from anywhere in the room.

I observed that several of his students were not taking notes during the class but were concentrating on listening and trying to understand the presentation. I wondered about this and asked one of his students about it after class. The student suggested that he scan in his handwritten lecture notes and post them on Blackboard so that the class could access them after class and could spend their classroom time listening without copying down what he writes on the board.

The topic of the lecture was signal propagation through and refraction by the ionosphere and the role of signal refraction in the way that GPS receivers calculate pseudorange. There are aspects of this topic which, at first glance, are at odds with special relativity, and Dr. Humphreys pointed this out. He then explained what was really going on in language that undergraduates and graduate students could understand. At several points during the lecture, he pointed out where particular results would be useful in the course laboratory. It was very clear that he had planned his lecture very well. Several times during the lecture, he used very informative and striking analogies to help explain concepts. However, Dr. Humphreys seemed to make a very difficult topic almost too easy to understand. I thought I understood clearly what he was saying, but after class, I wasn't so sure that I grasped it all.

Overall, Dr. Humphreys is a master of the course material and very much at home in the classroom. His rapport with the class is very good. He is very effective as an instructor for this course. His enthusiasm for the course material is contagious. This enthusiasm, above all, is the primary reason for his effectiveness in the classroom. I rate his teaching as excellent.

**Northcutt, Bonnie B**

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**From:** Fowler, Wallace T  
**Sent:** Wednesday, November 16, 2011 9:44 AM  
**To:** Northcutt, Bonnie B  
**Subject:** RE: Dr. Fowler's peer review of Todd Humphreys

I met with him on the Monday, October 24, 2011 after I reviewed his class on Thursday, October 20.

Wally

**From:** Northcutt, Bonnie B  
**Sent:** Wednesday, November 16, 2011 9:40 AM  
**To:** Fowler, Wallace T  
**Subject:** FW: Dr. Fowler's peer review of Todd Humphreys

Dr. Fowler: I now have your review of Todd Humphreys. Can you please confirm when you met with him to discuss your review?

Thanks, Bonnie

**Bonnie B. Northcutt**  
**Executive Assistant**  
The University of Texas at Austin  
ASE/EM Department  
210 E. 24th Street, WRW 215E  
1 University Station, C0600  
Austin, TX 78712-0735  
512.471.5145  
[bnorth@mail.utexas.edu](mailto:bnorth@mail.utexas.edu)  
<http://www.ae.utexas.edu>



**From:** Ricke, Sara A  
**Sent:** Friday, November 11, 2011 9:52 AM  
**To:** Northcutt, Bonnie B  
**Subject:** Dr. Fowler's peer review of Todd Humphreys

Philip has the hard copy on his desk as of right now.

Thanks,

Sara



AEROSPACE ENGINEERING & ENGINEERING MECHANICS  
THE UNIVERSITY OF TEXAS AT AUSTIN

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210 E. 24<sup>th</sup> Street, WRW · Tel: 512-471-7593 · Fax: 512-471-3788  
1 University Station C0600 · Austin, Texas 78712-0235

Feb. 9, 2013

To: Prof. Noel Clemens

From: Prof. David Goldstein 

Re: Teaching Evaluation of Prof. Todd Humphreys

On 2/8/13 I attended a ASE 389P class on GPS given by Prof. Humphreys. The class began at 11am. There were 6 students in attendance and a seventh arrived late. Prof. Humphreys had a cold.

Prof. Humphreys briefly finished up some material from a previous class and then began to discuss why some particular spectrum was flat and how to detect the GPS signal above the noise. He phrased the problem as a clear question and answer on the board. One student (Travis) asked a perceptive question about averaging signals and he and Prof. Humphreys had a good exchange. Another student asked about FM radio and also was engaged in a good exchange. In fact, throughout the class there were several such Q and A exchanges as Prof. Humphreys spoke about GPS and cryptography. He referenced a technical paper he had posted on Blackboard and worked on issues related to generating pseudo-random spreading codes and random vs. deterministic processes.

Prof. Humphreys spoke with expression and recalled student responses from a previous class. He briefly interrupted the lecture to allow small groups of students to discuss an answer to a question he posed. As he worked from written notes he successfully kept the students engaged in the subject for the entire 57 minutes (he went a bit long). His lecture and discussion style were excellent and the high grades he receives from the students in his end of semester evaluations are well deserved.

*We met 2/15/13*

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Peer Review of Teaching

Course: ASE 372 N – Satellite based Navigation  
Instructor: Todd Humphreys, Assistant Professor, ASE-EM Department  
Date of class: November 19, 2013

This is a moderately sized undergraduate class with approximately 20 students enrolled. Attendance was moderate on the day I visited – several students came in a few minutes late and perhaps 2/3 of the class was there ultimately. Prof. Humphreys started on time and did not let the latecomers interrupt the discussion. He began by describing a conference he had just attended and the impact of a presentation he had made on his group's research that demonstrated cm precision location capability on a Samsung phone. I believe the students enjoyed this linkage of the course material with current research.

The class was a review for an upcoming evening exam and he tried to make the students come up with questions to which he could respond. He also posed a few questions to the class and spent time trying to draw out student responses and comments. Although there were a couple of weeks left in the semester when I attended, Todd informed me that the rest of the time would be spent in discussing student projects so there were no further lectures scheduled for the semester and I had no opportunity to observe a more traditional lecture presentation. Among the questions discussed were issues of precision, and the concept that zero error in the least-squares cost estimate does not necessarily translate into high precision. The class also discussed what constitutes a "clock" in relativity and whether a time-stamped radio transmission would be subject to gravitational time dilation.

His use of the chalkboard was traditional and quite effective. Todd is clearly comfortable with the material and did not need to refer to notes for this review. I had the sense that he routinely attempts to engage the students in the presentation by asking leading questions and awaiting their response. He has an engaging classroom presence and it is clear that the students enjoy his presentation style. Overall, I believe he is a very effective teacher.

Prepared by:

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Philip L. Varghese  
Distinguished Teaching Professor  
ASE-EM Department

Discussed review with T. Humphreys on January 10 2014

**Gonzales, Laurie**

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**From:** Varghese, Philip L  
**Sent:** Tuesday, January 07, 2014 5:19 PM  
**To:** todd.humphreys@mail.utexas.edu  
**Cc:** Gonzales, Laurie  
**Subject:** Peer teaching review  
**Attachments:** Humphreys Peer Teaching Review F-13.docx

Todd,

I enclose my review of your class from last semester. Sorry for the delay. Please take a look and let me know if there are any errors of fact, or significant omissions.

I am out of town at the moment but, after any iterations to correct mistakes, we should meet briefly to discuss the review and sign the document before I transmit it officially to Laurie.

Let me know.

Thanks,

Philip

Philip L Varghese  
Distinguished Teaching Professor  
Stanley P. Finch Centennial Professor in Engineering  
Director, Center for Aeromechanics Research  
ASE-EM Department, WRW 314C  
The University of Texas at Austin  
210 E. 24th St, Stop C0600  
Austin, TX 78712  
1-512-471-3110 (office)  
1-512-471-3788 (fax)

**Professor Todd Humphrey**

**ASE 381P-8, Stochastic Detection, Estimation and Control**

**WRW 413, 11:00 am to 12:30 pm, Thursday, April 3, 2014**

**Peer teaching review by Professor Thomas J.R. Hughes:**



The handwritten signature of Professor Thomas J.R. Hughes is written over a horizontal line. To the right of the signature is the date 4/15/14.

The class was small with 11 students in attendance. The students handed in their take home exams that were apparently due at the beginning of the class. As the students were getting settled, Professor Humphrey wrote a brief outline of the day's lecture on the left-hand side of the blackboard.

Professor Humphrey began by asking the students if there were any questions concerning the exam he had given, and in particular asking if there were any surprises. A student named Assad asked a question about RMS values of the differences in sets of samples. Professor Humphrey presented a discussion of the concepts involved and their meaning. The same student followed up with very incisive questions, and other students chimed in with additional thoughts. Professor Humphrey seemed to enjoy the interaction with them and exhibited enthusiasm in his responses. The interchange was interesting and I found myself listening attentively, forgetting that I had a peer revaluation to write. Back to work!

Ten minutes into the class it was already manifestly apparent that Professor Humphrey is a skilled teacher and develops a great rapport with his students. He really seems to enjoy teaching. He mentioned in passing that he would do this without pay, but he said grading exams was quite another matter. Amen. He asked the class if they appreciated the personalized individual comments he included on each of their exams as part of the grading. The response was unanimous affirmation.

The students seemed to be very comfortable in class and not intimidated at all with being asked to respond to questions that Professor Humphrey asked. At different times in the lecture he asked different students to explain various things, and very patiently engaged in discussions with them that elicited the responses he was hoping for. There was very good class participation, and there seemed to be complete attention to everything he said and wrote on the board. There were many smiling faces among the students, a good sign.

Professor Humphrey then began his prepared lecture. The goal was to develop the Square Root Information Smoother (SRIS) for some particular cases. His board work was very clear. After writing an important equation on the board, he asked one of the students if he recognized it from previous lectures and asked the student

the name of the equation. He then proceeded to elaborate on the system of "Square Root Information Equations," continuously commenting on their meaning and interpretation.

Professor Humphrey proceeded with a discussion of a curious and non-intuitive phenomenon, and referred to a beautiful paper explaining it. The paper had been uploaded on Blackboard for the class.

Professor Humphrey then raised additional questions and students responded with some insightful remarks. It is clear that students learn a lot in class. Professor Humphrey is not just lecturing (nothing wrong with that), but teaching and creating appreciation and understanding of the material interactively with the students. He addressed the students by their first names.

Professor Humphrey then commenced to present the SRIS Algorithm in "six easy steps," and proceeded to describe each of the steps. The material was very technical, but Professor Humphrey brought it to light with many comments and insights. He frequently engaged the students on various aspects of the steps, keeping their attention throughout a long development. He also mentioned that they would have to implement the algorithm in their homework assignments. The presentation was detailed and carefully done. The remainder of the class was devoted to the presentation of the SRIS Algorithm.

In closing, he presented a brief prelude to the development of Kalman filters for nonlinear problems, the topic that the class will address in ensuing lectures, and some of the subtle and complex issues to be encountered. Stay tuned.

Professor Humphrey has an engaging personality and is a charismatic teacher. He is serious, but has a sense of whimsy and includes amusing quips continuously while lecturing. He is enthusiastic, enjoys his work, and is very, very good at it. The upshot is not surprising: His students seem to very much appreciate the excellence he exhibits in his teaching.

Recommendations for improvement: I have been teaching for over 40 years and I think I learned a few things today. I have a lecture to give in an hour and a half and I am going to try to instill it with a few of the ideas I picked up from listening to Professor Humphrey. I would suggest in his case we just leave well enough alone. There is no point in tampering with the talent of "the natural."

**Gonzales, Laurie**

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**From:** Gonzales, Laurie  
**Sent:** Monday, April 14, 2014 5:05 PM  
**To:** Tom Hughes  
**Subject:** RE: Reminder: Peer Teaching Reviews

We'll count that as a meeting. You offered to speak with him but he was okay with the report as-is. Please submit a copy to me at your earliest convenience for Dr. Humphreys' file.

**From:** Tom Hughes [[mailto:tjr\\_hughes@hotmail.com](mailto:tjr_hughes@hotmail.com)]  
**Sent:** Monday, April 14, 2014 5:02 PM  
**To:** Gonzales, Laurie  
**Subject:** RE: Reminder: Peer Teaching Reviews

Laurie,

We did not meet. I sent him the report electronically and he sent me a message back saying he was happy with it.

Tom

Dr. Thomas J.R. Hughes  
Professor of Aerospace Engineering and Engineering Mechanics  
Computational and Applied Mathematics Chair III  
201 East 24th Street, Stop C0200  
Austin, TX 78712-1229 U.S.A.

512 232 7775 tel  
512 232 7508 fax

[hughes@ices.utexas.edu](mailto:hughes@ices.utexas.edu)  
[tjr\\_hughes@hotmail.com](mailto:tjr_hughes@hotmail.com)

Web page: <http://www.ices.utexas.edu/%7Ehughes/>  
IGA Short Course at WCCM, Barcelona: <http://congress.cimne.com/igaschool2014>

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**From:** [laurie.gonzales@austin.utexas.edu](mailto:laurie.gonzales@austin.utexas.edu)  
**To:** [tjr\\_hughes@hotmail.com](mailto:tjr_hughes@hotmail.com)  
**Subject:** RE: Reminder: Peer Teaching Reviews  
**Date:** Mon, 14 Apr 2014 20:35:21 +0000

That would be fine. Please follow up the report with an email that mentions the date you met with Dr. Humphreys to discuss.

**From:** Tom Hughes [[mailto:tjr\\_hughes@hotmail.com](mailto:tjr_hughes@hotmail.com)]  
**Sent:** Monday, April 14, 2014 3:32 PM  
**To:** Gonzales, Laurie  
**Subject:** RE: Reminder: Peer Teaching Reviews

Dear Laurie,

Mine is done and I sent it to Todd for review. He is happy with it, but we have not met face to face. Can I sign it and send it you anyway?

Best regards,

Tom

Dr. Thomas J.R. Hughes  
Professor of Aerospace Engineering and Engineering Mechanics  
Computational and Applied Mathematics Chair III  
201 East 24th Street, Stop C0200  
Austin, TX 78712-1229 U.S.A.

512 232 7775 tel  
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Web page: <http://www.ices.utexas.edu/%7Ehughes/>  
IGA Short Course at WCCM, Barcelona: <http://congress.cimne.com/igaschool2014>

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From: [laurie.gonzales@austin.utexas.edu](mailto:laurie.gonzales@austin.utexas.edu)  
To: [hughes@ices.utexas.edu](mailto:hughes@ices.utexas.edu); [leszek@ices.utexas.edu](mailto:leszek@ices.utexas.edu); [hmark@mail.utexas.edu](mailto:hmark@mail.utexas.edu)  
CC: [tclarson@mail.utexas.edu](mailto:tclarson@mail.utexas.edu)  
Subject: Reminder: Peer Teaching Reviews  
Date: Mon, 14 Apr 2014 18:03:31 +0000  
Good afternoon:

Just a quick reminder that the last class day, May 2<sup>nd</sup>, is quickly approaching and I've not yet received your Spring 2014 Peer Teaching Review. If you've not yet had the opportunity to observe your assigned instructor in action, please do so at your earliest convenience. I'm happy to provide his or her teaching schedule, if you need it.

Cheers,  
Laurie

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Laurie Gonzales  
Department Manager  
Aerospace Engineering and Engineering Mechanics  
Cockrell School of Engineering  
The University of Texas at Austin  
210 E. 24<sup>th</sup> Street Stop C0600  
Austin, Texas 78712-1221  
(512) 471-5145 Direct  
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(512) 471-3788 Fax

HUMPHREYS, TODD E

Engineering  
Aerospace Engineering

08/02/14

Summary of Recent (All Years In Rank) UT Austin Course-Instructor Survey Result  
Overall Course/Instructor Items

Semester	Course Number	Course Title	Enrollment			Instructor Averages*			College/School Averages**		
			No. of Students Enrolled	No. of Surveys Returned at End of Class Day	Avg.	Overall Instructor Rating	Avg.	Overall Instructor Rating	Avg.	No. Classes Surveyed	
Fall 09	ASE 366K	SPACECRAFT DYNAMICS	78	55	4.8	4.3	N/A ***	N/A ***	N/A		
Spring 10	ASE 389P	7-GLOBAL POSITIONING SYSTEM	11	8	4.9	4.8	N/A ***	N/A ***	N/A		
Fall 10	ASE 366K	SPACECRAFT DYNAMICS	78	33	4.6	4.5	N/A ***	N/A ***	N/A		
Spring 11	ASE 679HB	UNDERGRADUATE HONORS THESIS	1	1	5.0	5.0	N/A ***	N/A ***	N/A		
Spring 11	ASE 398R	MASTER'S REPORT	1	1	1.0	1.0	N/A ***	N/A ***	N/A		
Spring 11	ASE 389P	7-GLOBAL POSITIONING SYSTEM	7	5	4.6	4.8	N/A ***	N/A ***	N/A		
Fall 11	ASE 372N	SATELLITE-BASED NAVIGATION	16	7	4.7	4.9	N/A ***	N/A ***	N/A		
Spring 12	ASE 396	MODEL-BASED DETECTION/ESTIMATN	24	20	4.7	4.6	N/A ***	N/A ***	N/A		
Fall 12	ASE 372N	SATELLITE-BASED NAVIGATION	16	7	4.6	4.4	N/A ***	N/A ***	N/A		
Spring 13	ASE 389P	7-GLOBAL POSITIONING SYSTEM	5	4	4.8	4.5	N/A ***	N/A ***	N/A		
Fall 13	ASE 372N	SATELLITE-BASED NAVIGATION	18	3	5.0	4.7	N/A ***	N/A ***	N/A		
Spring 14	ASE 381P	8-STOCH DETEC, ESTM, & CNTRL	12	8	4.8	4.6	N/A ***	N/A ***	N/A		

\*For the computation of the averages, points were assigned to student responses as follows:  
Excellent = 5, Very Good = 4, Satisfactory = 3, Unsatisfactory = 2, Very Unsatisfactory = 1

\*\*College/school averages are the average of class averages, based on all courses surveyed in the instructor's college or school during the academic year in which the course was taught.

\*\*\*New CIS forms were implemented in the fall 2000 semester. The average rating on the overall course and instructor questions on the new Basic and Expanded forms have been found to be approximately 0.1 to 0.2 points lower than those ratings on the old Common form.

Prepared by the Measurement and Evaluation Center

Page 1

## Results

[https://utdirect.utexas.edu/ctl/ecis/results/results.WBX?website\\_swit..](https://utdirect.utexas.edu/ctl/ecis/results/results.WBX?website_swit..)

## \*\*\* PROVISIONAL REPORT \*\*\*

UNIVERSITY OF TEXAS AT AUSTIN Humphreys, Todd E ASE381P 13985	COURSE-INSTRUCTOR SURVEY G-STOCK DETEC, ESTM, & CNTL	Spring 2014 DEPARTMENT COPY Enrollment = 11 Surveys Returned = 8					
NUMBER CHOOSING EACH RESPONSE							
	Str Disag	Disagree	Neutral	Agree	Str Agree	NO. REPILES THIS ITEM	Avg.
1 COURSE WELL-ORGANIZED	0	0	0	0	8	8	5.0
2 COMMUNICATED INFORMATION EFFECTIVELY	0	0	1	0	7	6	4.8
3 SHOWED INTEREST IN STUDENT PROGRESS	0	0	1	4	3	8	4.3
4 ASSIGNMENTS AND TESTS RETURNED PROMPTLY	0	2	2	4	0	6	3.3
5 STUDENT FREEDOM OF EXPRESSION	0	0	1	2	5	6	4.5
6 COURSE OF VALUE TO DATE	0	0	0	3	5	6	4.6
7 OVERALL INSTRUCTOR RATING	Vry Unsat	Unsat	Satisfact	Vary Good	Excellent		
8 OVERALL COURSE RATING	0	0	0	2	6	6	4.8
9 STUDENT RATING OF COURSE WORKLOAD	Excessive	High	Average	Light	Insuffic		
10 OVERALL UT GRADE POINT AVERAGE	Less 2.00	2.00-2.49	2.50-2.99	3.00-3.49	3.50+4.00		
11 PROBABLE COURSE GRADE	$\frac{A}{5}$	$\frac{B}{5}$	$\frac{C}{5}$	$\frac{D}{5}$	$\frac{F}{5}$		

For the computation of averages, values were assigned on a 5-point scale so that the most favorable response was assigned a value of 5 and the least favorable response was assigned a value of 1.

## Results

[https://utdirect.utexas.edu/ctl/ecis/results/results.WBX?website\\_swit...](https://utdirect.utexas.edu/ctl/ecis/results/results.WBX?website_swit...)

UNIVERSITY OF TEXAS AT AUSTIN Humphreys, Todd S B000 Basic		ASS372N	13895	COURSE-INSTRUCTOR SURVEY SATELLITE-BASED NAVIGATION	Fall 2013 DEPARTMENT COPY			
				Enrollment = 16	Surveys Returned = 3			
		NUMBER CHOOSING EACH RESPONSE					NO. REPIES THIS ITEM	Avg.
1 COURSE WELL-ORGANIZED	Str Disag	Disagree	Neutral	Agree	Str Agree			
1 COURSE WELL-ORGANIZED	0	0	0	2	1	3	4.3	
2 COMMUNICATED INFORMATION EFFECTIVELY	0	0	0	0	3	3	5.0	
3 SHOWED INTEREST IN STUDENT PROGRESS	0	0	0	1	2	3	4.7	
4 ASSIGNMENTS AND TESTS RETURNED PROMPTLY	0	0	0	2	1	3	4.3	
5 STUDENT FREEDOM OF EXPRESSION	0	0	0	1	2	3	4.7	
6 COURSE OF VALUE TO DATE	0	0	0	1	2	3	4.7	
7 OVERALL INSTRUCTOR RATING	Vry Unsat	Unsat	Satisfact	Very Good	Excellent			
7 OVERALL INSTRUCTOR RATING	0	0	0	0	3	3	5.0	
8 OVERALL COURSE RATING	0	0	.	1	2	3	4.7	
9 STUDENT RATING OF COURSE WORKLOAD	Excessive	High	Average	Light	Insuffic			
9 STUDENT RATING OF COURSE WORKLOAD	0	3	0	0	0	3		
10 OVERALL UT GRADE POINT AVERAGE	Less 2.00	2.00-2.49	2.50-2.99	3.00-3.49	3.50-4.00			
10 OVERALL UT GRADE POINT AVERAGE	0	0	1	1	1	3		
11 PROBABLE COURSE GRADE	A-	B-	C-	D-	F			
11 PROBABLE COURSE GRADE	0	1	1	0	0	3		

For the computation of averages, values were assigned on a 5-point scale so that the most favorable response was assigned a value of 5 and the least favorable response was assigned a value of 1.

## Results

[https://utdirect.utexas.edu/ctl/ecis/results/results.WBX?website\\_swit...](https://utdirect.utexas.edu/ctl/ecis/results/results.WBX?website_swit...)

UNIVERSITY OF TEXAS AT AUSTIN Humphreys, Todd E. ASSESSOR 8000 Basic	13530	COURSE-INSTRUCTOR SURVEY 7-GLOBAL POSITIONING SYSTEM	Spring 2013 DEPARTMENT COPY Enrollment = 5 Surveys Returned = 4		
NUMBER CHOOSING EACH RESPONSE					
1 COURSE WELL-ORGANIZED	Str Disag	Disagree	Neutral		
2 COMMUNICATED INFORMATION EFFECTIVELY	0	0	0		
3 SHOWED INTEREST IN STUDENT PROGRESS	0	0	0		
4 ASSIGNMENTS AND TESTS RETURNED PROMPTLY	0	0	0		
5 STUDENT FREEDOM OF EXPRESSION	0	0	0		
6 COURSE OF VALUE TO DATE	0	0	0		
7 OVERALL INSTRUCTOR RATING	Vry Unsat	Unsat	Satisfact		
8 OVERALL COURSE RATING	0	0	0		
9 STUDENT RATING OF COURSE WORKLOAD	Excessive	High	Average		
10 OVERALL UT GRADE POINT AVERAGE	Less 2.00	2.00-2.49	2.50-2.99	3.00-3.49	3.50-4.00
11 PROBABLE COURSE GRADE	$\frac{A}{2}$	$\frac{B}{2}$	$\frac{C}{2}$	$\frac{D}{2}$	$\frac{F}{2}$

For the computation of averages, values were assigned on a 5-point scale so that the most favorable response was assigned a value of 5 and the least favorable response was assigned a value of 1.

## Results

[https://utdirect.utexas.edu/ctl/ecis/results/results.WBX?website\\_swit...](https://utdirect.utexas.edu/ctl/ecis/results/results.WBX?website_swit...)

UNIVERSITY OF TEXAS AT AUSTIN Humphreys, Todd E BOJO Basic	ASE372N	13530	COURSE-INSTRUCTOR SURVEY SATELLITE-BASED NAVIGATION	Fall 2012 DEPARTMENT COPY Enrollment = 16 Surveys Returned = 7	
NUMBER CHOOSING EACH RESPONSE					
1 COURSE WELL-ORGANIZED	Str Disag	Disagree	Neutral	Agree	
2 COMMUNICATED INFORMATION EFFECTIVELY	0	0	0	3	
3 SHOWED INTEREST IN STUDENT PROGRESS	0	0	1	4	
4 ASSIGNMENTS AND TESTS RETURNED PROMPTLY	0	0	0	2	
5 STUDENT FREEDOM OF EXPRESSION	0	0	1	0	
6 COURSE OF VALUE TO DATE	0	0	0	2	
7 OVERALL INSTRUCTOR RATING	Vry Unsat	Unsat	Satisfact	Very Good	
8 OVERALL COURSE RATING	0	0	0	4	
9 STUDENT RATING OF COURSE WORKLOAD	Excessive	High	Average	Light	
10 OVERALL UT GRADE POINT AVERAGE	Less 2.00	2.00-2.49	2.50-2.99	3.00-3.49	3.50-4.00
11 PROBABLE COURSE GRADE	<u>A</u> 0	<u>B</u> 5	<u>C</u> 1	<u>D</u> 0	<u>F</u> 0

For the computation of averages, values were assigned on a 5-point scale so that the most favorable response was assigned a value of 7 and the least favorable response was assigned a value of 1.

## Results

[https://utdirect.utexas.edu/ctl/ecis/results/results.WBX?website\\_swit...](https://utdirect.utexas.edu/ctl/ecis/results/results.WBX?website_swit...)

UNIVERSITY OF TEXAS AT AUSTIN Humphreys, Todd H B000 Basic	ASE396	13578	COURSE-INSTRUCTOR SURVEY MODEL-BASED DECTCTION/ESTIMATIN	Spring 2012 DEPARTMENT COPY Enrollment = 24 Surveys Returned = 20	
NO. REPLIES THIS ITEM					
			NUMBER CHOOSING EACH RESPONSE	Avg.	
			Str Disag	Disagree	
1 COURSE WELL-ORGANIZED		0	0	0	
2 COMMUNICATED INFORMATION EFFECTIVELY		0	0	1	
3 SHOWED INTEREST IN STUDENT PROGRESS		0	1	1	
4 ASSIGNMENTS AND TESTS RETURNED PROMPTLY		0	2	8	
5 STUDENT FREEDOM OF EXPRESSION		0	2	0	
6 COURSE OF VALUE TO DATE		0	0	1	
			Agree	Str Agree	
7 OVERALL INSTRUCTOR RATING	Vry Unsat	0	5	12	
8 OVERALL COURSE RATING	Unsat	0	5	14	
	Satisfact	1	12	20	
9 STUDENT RATING OF COURSE WORKLOAD	Very Good	7	12	20	
	Excellent				
10 OVERALL UT GRADE POINT AVERAGE	Excessive	5	0	0	
	High	11	0	20	
	Average	4	0		
	Light	0	3		
	Insuffic	0	17		
	Less 2.00	2.00-2.49	2.50-2.99	3.00-3.49	3.50-4.00
11 PROBABLE COURSE GRADE	-A-	-B-	-C-	-D-	-F-
		19	5	6	0
					19

For the computation of averages, values were assigned on a 5-point scale so that the most favorable response was assigned a value of 5 and the least favorable response was assigned a value of 1.

## Results

[https://utdirect.utexas.edu/ctl/ecis/results/results.WBX?website\\_swit..](https://utdirect.utexas.edu/ctl/ecis/results/results.WBX?website_swit..)

UNIVERSITY OF TEXAS AT AUSTIN Humphreys, Todd E ASE372N 13740		COURSE-INSTRUCTOR SURVEY SATELLITE-BASED NAVIGATION		FALL 2011 DEPARTMENT COPY				
				Enrollment = 14	Surveys Returned = 7			
NUMBER CHOOSING EACH RESPONSE								
		THIS ITEM			NO. REPLIES			
		Str Disag	Disagree	Neutral	Agree	Str Agree	AVG.	
1 COURSE WELL-ORGANIZED		0	0	0	1	6	7	4.9
2 COMMUNICATED INFORMATION EFFECTIVELY		0	0	0	2	5	7	4.7
3 SHOWED INTEREST IN STUDENT PROGRESS		0	0	1	1	5	7	4.6
4 ASSIGNMENTS AND TESTS RETURNED PROMPTLY		0	0	1	2	4	7	4.4
5 STUDENT FREEDOM OF EXPRESSION		0	0	0	2	5	7	4.7
6 COURSE OF VALUE TO DATE		0	0	0	1	6	7	4.9
		Very Unsat	Unsat	Satisfact	Very Good	Excellent		
7 OVERALL INSTRUCTOR RATING		0	0	0	2	5	7	4.7
8 OVERALL COURSE RATING		0	0	0	1	6	7	4.9
		Excessive	High	Average	Light	Insuffic		
9 STUDENT RATING OF COURSE WORKLOAD		2	3	2	0	0	7	
		Less 2.00	2.00-2.49	2.50-2.99	3.00-3.49	3.50-4.00		
10 OVERALL UT GRADE POINT AVERAGE		0	0	0	1	6	7	
		<u>A</u> <u>3</u>	<u>B</u> <u>4</u>	<u>C</u> <u>5</u>	<u>D</u> <u>6</u>	<u>E</u> <u>5</u>	7	
11 PROBABLE COURSE GRADE								

For the computation of averages, values were assigned on a 5-point scale so that the most favorable response was assigned a value of 5 and the least favorable response was assigned a value of 1.

## Results

[https://utdirect.utexas.edu/ctl/ecis/results/results.WBX?website\\_swit...](https://utdirect.utexas.edu/ctl/ecis/results/results.WBX?website_swit...)

UNIVERSITY OF TEXAS AT AUSTIN		COURSE-INSTRUCTOR SURVEY					Spring 2011 DEPARTMENT COPY		
Humphreys, Todd E ASE389P		7-GLOBAL POSITIONING SYSTEM					Enrollment = 7 Surveys Returned = 5		
		NUMBER CHOOSING EACH RESPONSE					NO. REPIES THIS ITEM		Avg.
1 COURSE WELL-ORGANIZED	Str Disag	Disagree	Neutral	Agree	Str Agree				
1 COURSE WELL-ORGANIZED	0	0	0	1	4		5		4.8
2 COMMUNICATED INFORMATION EFFECTIVELY	0	0	0	2	3		5		4.6
3 SHOWED INTEREST IN STUDENT PROGRESS	0	0	1	1	3		5		4.4
4 ASSIGNMENTS AND TESTS RETURNED PROMPTLY	0	0	1	2	2		5		4.2
5 STUDENT FREEDOM OF EXPRESSION	0	0	1	1	3		5		4.4
6 COURSE OF VALUE TO DATE	0	0	0	2	3		5		4.6
7 OVERALL INSTRUCTOR RATING	Vry Unsat	Unsat	Satisfact	Very Good	Excellent		5		4.6
8 OVERALL COURSE RATING	0	0	0	1	4		5		4.8
9 STUDENT RATING OF COURSE WORKLOAD	Excessive	High	Average	Light	In suffic		5		
10 OVERALL UT GRADE POINT AVERAGE	Less 2.00	2.00-2.49	2.50-2.99	3.00-3.49	3.50-4.00		4		
11 PROBABLE COURSE GRADE	<u>A</u> 4	<u>B</u> 0	<u>C</u> 0	<u>D</u> 0	<u>F</u> 0		4		

For the computation of averages, values were assigned on a 5-point scale so that the most favorable response was assigned a value of 5 and the least favorable response was assigned a value of 1.

## Results

[https://uidirect.utexas.edu/cil/ecis/results/results.WBX?website\\_swit...](https://uidirect.utexas.edu/cil/ecis/results/results.WBX?website_swit...)

UNIVERSITY OF TEXAS AT AUSTIN		COURSE-INSTRUCTOR SURVEY		Fall 2010 DEPARTMENT COPY				
Humphreys, Todd E ASE366K 13310		SPACECRAFT DYNAMICS		Enrollment = 75 Surveys Returned = 33				
NUMBER CHOOSING EACH RESPONSE								
				NO. REPLIES THIS ITEM				
		Str Disag	Disagree	Neutral	Agree	Str Agree	Avg.	
1 COURSE WELL-ORGANIZED		0	0	0	6	27	33	4.6
2 COMMUNICATED INFORMATION EFFECTIVELY		0	0	0	8	25	33	4.8
3 SHOWED INTEREST IN STUDENT PROGRESS		0	2	0	10	21	33	4.5
4 ASSIGNMENTS AND TESTS RETURNED PROMPTLY		0	0	0	14	19	33	4.6
5 STUDENT FREEDOM OF EXPRESSION		0	1	1	5	25	32	4.7
6 COURSE OF VALUE TO DATE		0	0	2	9	22	33	4.6
		Vry Unsat	Unsat	Satisfact	Very Good	Excellent		
7 OVERALL INSTRUCTOR RATING		0	0	2	9	22	33	4.6
8 OVERALL COURSE RATING		0	1	2	10	20	33	4.5
		Excessive	High	Average	Light	Insuffic		
9 STUDENT RATING OF COURSE WORKLOAD		0	12	19	2	0	33	
		Less 2.00	2.00-2.49	2.50-2.99	3.00-3.49	3.50-4.00		
10 OVERALL UT GRADE POINT AVERAGE		0	1	9	10	13	33	
		A	B	C	D	F		
11 PROBABLE COURSE GRADE		10	12	9	1	1	33	

For the computation of averages, values were assigned on a 5-point scale so that the most favorable response was assigned a value of 5 and the least favorable response was assigned a value of 1.

## Results

[https://utdirect.utexas.edu/ctl/ecis/results/results.WBX?website\\_swit...](https://utdirect.utexas.edu/ctl/ecis/results/results.WBX?website_swit...)

UNIVERSITY OF TEXAS AT AUSTIN Humphreys, Todd E ASE389P 13603	COURSE-INSTRUCTOR SURVEY 7-GLOBAL POSITIONING SYSTEM	Spring 2010 DEPARTMENT COPY Enrollment = 11 Surveys Returned = 8					
NUMBER CHOOSING EACH RESPONSE							
	Str Disag	Disagree	Neutral	Agree	Str Agree	NO. REPLIES THIS ITEM	AVG.
1 COURSE WELL ORGANIZED	0	0	1	1	6	8	4.6
2 COMMUNICATED INFORMATION EFFECTIVELY	0	0	1	0	7	8	4.8
3 SHOWED INTEREST IN STUDENT PROGRESS	0	0	0	0	8	8	5.0
4 ASSIGNMENTS AND TESTS RETURNED PROMPTLY	0	0	1	1	6	8	4.6
5 STUDENT FREEDOM OF EXPRESSION	0	0	0	1	7	8	4.9
6 COURSE OF VALUE TO DATE	0	0	0	1	7	8	4.9
7 OVERALL INSTRUCTOR RATING	Vry Unsat	Unsat	Satisfact	Very Good	Excellent		
8 OVERALL COURSE RATING	0	0	0	2	4	8	4.8
9 STUDENT RATING OF COURSE WORKLOAD	Excessive	High	Average	Light	Insuffic		
10 OVERALL UT GRADE POINT AVERAGE	Less 2.00	2.00-2.49	2.50-2.99	3.00-3.49	3.50-4.00		
11 PROBABLE COURSE GRADE	A	B	C	D	F		

For the computation of averages, values were assigned on a 5-point scale so that the most favorable response was assigned a value of 5 and the least favorable response was assigned a value of 1.

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Printed: 06/24/2014

## Results

[https://utdirect.utexas.edu/ctl/ecis/results/results.WBX?website\\_swit...](https://utdirect.utexas.edu/ctl/ecis/results/results.WBX?website_swit...)

UNIVERSITY OF TEXAS AT AUSTIN Bucphreys, Todd K ASE366K 13660		COURSE-INSTRUCTOR SURVEY SPACECRAFT DYNAMICS					Fall 2009 DEPARTMENT COPY Enrollment = 67 Surveys Returned = 55		
		NUMBER CHOOSING EACH RESPONSE					NO. REPLIES THIS ITEM		Avg.
		Str Disag	Disagree	Neutral	Agree	Str Agree			
1 COURSE WELL-ORGANIZED		0	0	0	11	44	55		4.8
2 COMMUNICATED INFORMATION EFFECTIVELY		0	0	0	13	42	55		4.8
3 SHOWED INTEREST IN STUDENT PROGRESS		0	1	1	7	45	54		4.6
4 ASSIGNMENTS AND TESTS RETURNED PROMPTLY		0	1	0	22	31	54		4.5
5 STUDENT FREEDOM OF EXPRESSION		0	0	0	10	45	55		4.8
6 COURSE OF VALUE TO DATE		1	0	4	12	38	55		4.6
7 OVERALL INSTRUCTOR RATING		Vry Unsat	Unsat	Satisfact	Very Good	Excellent			4.8
8 OVERALL COURSE RATING		0	0	0	12	43	55		4.3
9 STUDENT RATING OF COURSE WORKLOAD		Excessive	High	Average	Light	Insuffic			54
10 OVERALL UT GRADE POINT AVERAGE		Less 2.00	2.00-2.49	2.50-2.99	3.00-3.49	3.50-4.00			52
11 PROBABLE COURSE GRADE		R	B	C	D	F			54
		14	23	15	1	1			

For the computation of averages, values were assigned on a 5-point scale so that the most favorable response was assigned a value of 5 and the least favorable response was assigned a value of 1.

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Printed: 06/24/2014

09/04/14  
PROGRAM GSPBFRP3THE UNIVERSITY OF TEXAS AT AUSTIN  
OFFICE OF GRADUATE STUDIES IN  
COMMITTEE REPORT. MASTERS AND DOCTORAL  
FOR HUMPHREYS, TODD E.

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NAME	EID	LAST SEM	COMM POSITION	MAST OR DOCT	DEGREE	FIELD	YRS	2ND DEGREE	FIELD	YRS
APPAIAH, KUMAR	ka5835	132	MEMBER	D	PH.D.	ELECTRICAL AN	20132			
BHARGAVA, VIDUR	vb723	149	MEMBER	D						
BHATTI, JAHSHAN AHMED	jb24275	149	CHAIR	D						
BRIGHT, MARION WAYNE	mwb836	129	CHAIR	M	M.S.E.	AEROSPACE ENG	20129			
HUSSEIN HASSAN, EHAB M.	emh2247	149	MEMBER	D						
JIA, CHAO	cj7396	142	MEMBER	D	PH.D.	ELECTRICAL AN	20142			
JONES, DREW RYAN	dj5559	136	MEMBER	D	PH.D.	AEROSPACE ENG	20136			
JOPLIN, ANDREW J.	aj1274	119	MEMBER	M	M.S.E.	AEROSPACE ENG	20119			
KASSAS, ZAHER	zmk56	142	CO-CHAIR	D	PH.D.	ELECTRICAL AN	20142			
KO, JAEGAN	jk27656	149	MEMBER	D						
LIN, JING	j135446	142	MEMBER	D	PH.D.	ELECTRICAL AN	20142			
MCDANIEL WYMAN, C. A.	cam3948	139	MEMBER	M	M.A.	ENERGY AND EA	20112	M.S.E.	AEROSPACE ENG	20139
MORTAZAVI, YOUSOF	ym946	149	MEMBER	D						
MUNOZ, SEBASTIAN	munoz55	142	MEMBER	D						
NOVLAN, THOMAS DAVID	tdn55	122	MEMBER	D	PH.D.	ELECTRICAL AN	20122			
PESYNA, KENNETH MARK JR.	kmp2273	149	CHAIR	D						
SHEPARD, DANIEL PHILLIP	dps496	149	CHAIR	M	M.S.E.	AEROSPACE ENG	20132			
SMITH, NOAH HAROLD	noahsmitt	129	MEMBER	D	PH.D.	AEROSPACE ENG	20129			
TRUONG, KIEN TRUNG	ktt245	122	MEMBER	D	PH.D.	ELECTRICAL AN	20122			
VITTADEV, VIVEK	vv4338	149	MEMBER	D						
WANG, YEZHOU	yw4528	149	MEMBER	D						
WESSION, KYLE DOUGLAS	kw9625	142	CO-CHAIR	D	PH.D.	ELECTRICAL AN	20142			

**Post-Doctoral Fellow Supervision  
Todd Humphreys**

Dr. Humphreys has not supervised any postdoctoral fellows while in rank.

**Budget Council Assessment of Research, Publications & Other Evidence of  
Scholarship/Creativity for Todd Humphreys**

Prepared by: Leszek Demkowicz (Chair)

David Goldstein

Bob Schutz

**Introduction and Methodology**

The subcommittee relied on material provided by the candidate (e.g., CV, Research Statement, published papers, etc.) and external letters of reference. Comparisons were made to other ASE/EM faculty at similar stages of their career and to faculty at other institutions.

**Areas of Research**

Dr. Humphreys has focused on evolving areas of the satellite navigation field (an area of astronautics) and he has made significant contributions to this evolution as well as providing thoughtful guidance that has shaped the evolution such as 1) secure perception, 2) robust perception, 3) precision positioning and orientation for consumer mobile applications, and 4) instrumentation for remote sensing. Some of these areas did not exist two decades ago at the dawn of satellite navigation with the Global Positioning System, or GPS, but they have been made possible by the explosion of work in this application area, which includes the Russian satellite system (GLONASS), the European system, known as GALILEO, and the Chinese System, known as BEIDOU. Dr. Humphreys has contributed to all of the above areas, but he has focused on security aspects, an area that has received much attention in recent years. As Humphreys states in his Research Statement: [GPS is] "now ubiquitous in smartphones and tablets, enabling a host of location-based services." As a consequence, Dr. Humphreys' research overlaps in these research areas: for example, the consumer mobile applications overlaps with secure perception. When GPS (primarily a military system) was conceived, concern existed that an adversary could (or would) create false signal broadcasts that would create significant errors in navigation. These errors, known as "spoofing" of the signal led to the development of capabilities of GPS known as AS (or "anti-spoofing"). However, because GPS broadcast at two frequencies to enable a correction for the ionospheric delay, the innovative GPS community found ways to circumvent effects of AS (which is now part of the standard GPS signal), but it was thought that another part of the signal, known as C/A ("Clear/Access"), would not be subjected to spoofing. Dr. Humphreys and his team of students in the RadioNavigation Lab at UT (that Dr. Humphreys directs) showed that with the ubiquity of smartphones and tablets that provide GPS positioning, and which use the C/A signal only (because of cost and other issues related to full access of AS-limited signal), spoofing of C/A is possible and Dr. Humphreys demonstrated this characteristic using a drone and a multi-million dollar yacht (on loan for the experiment). In the case of the yacht, his experiment demonstrated in the Mediterranean that C/A

spoofing could enable commandeering the yacht's navigation system and produced unacceptable error in the navigation system. Dr. Humphreys was asked to testify to a U.S. congressional committee (an unusual event for an Assistant Professor or even a Full Professor). Dr. Humphreys' work has been recognized in his external letters (for example: Dr. Penina Axelrad, Chairperson of the Dept. of Aerospace Engineering Sciences at the University of Colorado Boulder, who is a GPS expert in her own right, notes in her letter that "Dr. Humphreys has published the most highly cited articles describing the threat [of] spoofing to GPS use and innovative detection strategies to insure the validity of position and timing solutions. He is widely recognized as an innovator and his work [is] highly valued because he has addressed this important issue through both analytical developments and experimental demonstration."

In addition to the citations noted by Dr. Axelrad, according to Google Scholar, since 2009, Dr. Humphreys has accumulated 881 citations for an h-index of 19, which is excellent for his age group and field.

Another letter (Dr. Jay Farrell, University of California, Riverside, and Chair of Electrical and Computer Engineering) expressed similar sentiments to Dr. Axelrad's as noted above (plus, he notes that [Dr. Humphreys] "has established an independent, well-funded, and well-publicized research program"; he also notes that [Dr. Humphreys] "has advised two Ph.D. students to completion, one of who has earned a faculty position, prior to [Dr. Humphreys] being evaluated for promotion to Associate Professor.) Dr. Farrell goes on to suggest that continued level of coverage with Congress and the national popular media, will serve to build Dr. Humphreys profile [toward becoming a] member of the National Academy of Engineering (NAE)." It is especially noteworthy that Dr. Farrell has never met Dr. Humphreys and he is only aware of Dr. Humphreys through his scholarly work.

### **Quantity and Quality of Research**

Dr. Humphreys publications have established the norms in the literature for their innovation and clarity—he has received over 120 citations of his first UT-authored paper, a remarkable achievement since the paper was published 5 years ago. In addition, this paper is regarded as a seminal paper, which prompted research by others in the field, further evidence of Dr. Humphreys' impact and guidance on the evolution of the field. Furthermore, the quantity and quality of Dr. Humphreys' publications is very high, which has been pointed out by his external review letters. Dr. Humphreys has published 15 refereed papers while in rank (for comparison, other ASE-EM faculty promoted from Assistant to Associate Professor in recent years have published 10, 11, 16, or 34 refereed papers while in rank of Assistant Professor. The authors of some of the external letters are aware of the publication norms at their institutions and others. The papers identified by Dr. Humphreys as his five most significant publications are all top-tier, high-quality peer-reviewed journals (e.g., *Journal of the Institute of Navigation*, *IEEE Transactions on Signal Processing*, *IEEE Transactions on Aerospace and Electronic Systems*,

and *IEEE Transactions on Intelligent Transportation Systems*. Dr. Humphreys has also published in a variety of “trade publications”, e.g. *GPS World* and *Inside GNSS* as well as conference proceedings. These publications generally reach a wider audience than the top-tier research journals, and many of them are either peer-reviewed or reviewed by an editorial board. In some respects these papers have broader impact than archival journals because of their timely availability.

### **Research Funding**

Dr. Humphreys has personally garnered a noteworthy \$1.8 million in external funding (his portion of almost \$4.4 million) to support his research. It is notable that a significant percentage of the total amount has been provided by private industry, from which it is notoriously difficult to obtain funding. This is especially noteworthy for an Assistant Professor. For comparison to other faculty members who have been promoted in recent years from Assistant to Associate Professor, the amount varies as follows: \$1.5M, 1.0M, 1.2M, 1.1M (these numbers are those for the individuals whose paper count is used above in ASE-EM).

### **Other Contributions**

Dr. Humphreys has been awarded two patents and a third one is pending. The awarded patents were completed during earlier periods preceding Dr. Humphreys' arrival at UT. The pending patent is based on work at UT, which was filed in February 2014 (hence, it is pending) and has not been awarded. Although the idea for the item originated with Dr. Humphreys, one of his students (D. Shepard) did most of the work and Dr. Humphreys chose to assign the patent to him, so the student is listed first.

### **Summary**

We wish to echo the statements made in the external review letters that Dr. Humphreys has published significant and innovative independent research as evidenced by his publications in top-tier research journals, he has testified before Congressional Committees on his research and its importance, he has set the directions for his research area and the research can be expected to further blossom in the coming years with the addition of the GALILEO (European) and BEIDOU (Chinese) satellite navigation constellations and other possible constellations. In summary, we expect Dr. Humphreys will continue to be a productive and valued member of the ASE-EM department. In our opinion, his research record is competitive and, in view of its impact and visibility, it exceeds the department and Cockrell School norms for promotion.

### **A Note on the External Reviewers**

The external reviewers ranged from a member of the National Academy of Engineering (NAE), namely Prof. Per Enge to department chairpersons at other universities, noted above, a leading researcher/developer at the NASA/CalTech Jet Propulsion Laboratory, and a Professor in

Australia who is the President of the International Association of Geodesy, to identify a portion of the contributors. All of the reviewers are well-known in this field and well-regarded.

**Five Most Significant Works**  
**Todd Humphreys**

1. Humphreys, T. E., "Detection Strategy for Cryptographic GNSS Anti-Spoofing," *IEEE Transactions on Aerospace and Electronic Systems*, vol. 49, no. 2, pp. 1073--1090, 2013.
2. Kassas, Z. M. and Humphreys, T. E., "Observability Analysis of Collaborative Opportunistic Navigation with Pseudorange Measurements," *IEEE Transactions on Intelligent Transportation Systems*, vol 15, pp. 260 – 273, Feb. 2014.
3. Pesyna, K.M., Z.M. Kassas, R.W. Heath, and T.E. Humphreys, "A Phase-Reconstruction Technique for Low-Power Centimeter-Accurate Mobile Positioning," *IEEE Transactions on Signal Processing*, vol. 62, pp. 2595 – 2610, May 2014.
4. Wesson, K., Rothlisberger, M., and Humphreys, T. E., "Practical Cryptographic Civil GPS Signal Authentication," *NAVIGATION, Journal of the Institute of Navigation*, vol. 59, no. 3, pp. 177--193, 2012.
5. Kerns, A. J., D. P. Shepard, J. A. Bhatti, and T. E. Humphreys, "Unmanned aircraft capture and control via GPS spoofing," *Journal of Field Robotics*, vol. 31, no. 4, pp. 617 – 636, 2014.

## STATEMENT ON RESEARCH

TODD HUMPHREYS

My research primarily develops theory and techniques for secure and robust perception, emphasizing navigation, collision avoidance, and timing perception, which are of special importance to the rise of autonomous vehicles and the smart grid. Two secondary research themes have been (1) precision positioning and orientation (pose) for consumer (mass-market) mobile applications, and (2) development of instrumentation for remote sensing.

### SECURE PERCEPTION

The next few decades will see pervasive autonomous control systems become critical to the world economy—from autonomous cars and aircraft to smart homes, smart cities, and vast energy, communication, and financial networks controlled at multiple scales. Protecting these systems from malicious attacks is a matter of urgent societal interest.

My secure perception research at the University of Texas has focused on an emergent category of cyber-physical attack that has seen little scrutiny in the secure control literature. Like cyber attacks, these attacks are hard to detect and can be executed from a distance, but unlike cyber attacks, they are effective *even against control systems whose software, data, and communications networks are secure*, and so can be considered a *more menacing long-term threat*. These are *field attacks*: attacks on the physical fields—electromagnetic, magnetic, acoustic, etc.—measured by system sensors. As specialized sensor attacks, field attacks seek to compromise a system’s perception of reality *non-invasively*—from without, not from within.

I am striving to develop a coherent analytical foundation for secure perception in the presence of field attacks and a suite of algorithms and tools to detect such attacks. A key insight behind my approach is that the physics of field attacks impose fundamental difficulties on the attacker. As with the one-way functions that underpin public-key cryptography, there are tests which are fundamentally difficult to circumvent even in the presence of process and measurement noise and when the system state is not fully observable from unaffected sensors. My approach seeks to progressively build security into navigation, collision avoidance, and timing perception from the physical sensory layer to the top-level state estimation algorithms.

**Research Impact.** The UT Radionavigation Laboratory, which I direct, is known worldwide for its research on secure perception.

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*Date:* September 12, 2014.

The first paper I published with a University of Texas byline, “Assessing the spoofing threat: Development of a portable GPS civilian spoofer” [1,2], can be credited with catalyzing modern research in location and timing security. From 1980 to 2008 (inclusive), there were approximately 20 journal, conference, or magazine articles published in the open literature on secure location or timing or the implications of these. Between 2009 and 2014 (inclusive)—a span of only 5 years compared to the earlier 28-year span—there have been hundreds of publications on these topics. That the surge in publications can be credited to my paper, which appeared in conference proceedings in late 2008 and in a trade magazine in early 2009, is evidenced by the timing of the surge and by the fact that my paper (between both versions) is the most cited reference on the subject, having 120+ citations, which is a large number for a 5-year-old paper in my field. The paper’s influence stems from its raising location and timing deception from a conceptual to a demonstrated threat.

My lab has conducted three high-profile demonstrations of navigation and timing deception of autonomous systems which have attracted international attention to my research. In fall 2011, at the invitation of a U.S. Dept. of Energy lab, we showed that the time synchronization of a phasor measurement unit, a critical element of the smart grid, could be arbitrarily manipulated by a field attack [3]. Months later, by invitation of the U.S. Dept. of Homeland Security, we conducted a live field attack in which a target UAV helicopter became remotely controllable as if caught in a tractor beam [4–6]. Finally, in June 2013 we demonstrated the surprising potency of a field attack targeting the navigation system of an \$80M superyacht: we drove the yacht several kilometers off course without triggering alarms [7,8]. The latter two demonstrations became the subject of significant worldwide news coverage [9].

My research has *directly influenced broad public policy* related to autonomous vehicles. I have twice testified before the U.S. Congress on safety and privacy in an age of drones [10,11], have contributed to two Government Accountability Office reports, was a special consultant for the National Risk Assessment of GPS Vulnerability, and directly contributed to Texas House Bill 912, which protects privacy by setting limits on public and private use of drones. Moreover, three significant government programs were initiated in large part due to my research, the FAA Alternative Position, Navigation, and Timing (APNT) program, started in 2010, the FAA GPS Intentional Interference and Spoofing Study Team (GIISST), convened just after I testified before congress in 2012, and a DOD study on modifying civil GPS signals to include digital signatures, in which my lab is playing a central role.

During my time at UT, my laboratory has authored or co-authored many journal [3,6,12–15], conference [1,5,16–30], and magazine [2,4,31–37] articles on secure perception of location and time. Reference [24] was awarded the best overall technical paper at the 2012 IEEE/ION PLANS conference.

Besides my congressional testimony, I have been invited as keynote speaker in conferences hosted by Cornell and the Royal Institute of Navigation, in addition to many other invited presentations. My TED talk on location security and privacy has nearly 600k views [38] and I have spoken to millions on security- and privacy-related topics through mass media outlets such as NPR, BBC, CBS, CNN, FOX, ABC, CSPAN, and The New York Times [9].

Funding for my research in secure perception has come from Northrop Grumman, the U.S. Defense Threat Reduction Agency, Harris Corporation, Coherent Navigation, Sandia National Laboratory, the U.S. Navy, and the U.S. Air Force. My share of total external funding in this area has been nearly \$1M.

### ROBUST PERCEPTION

Besides securing autonomous system perception against deliberate attack, another imperative is to *robustify* perception to ensure reliable autonomous system navigation, collision avoidance, and timing despite harsh sensing environments. My work on this topic has two themes: (1) precise vision-based sensing, and (2) massive signal-of-opportunity exploitation.

My work in vision-based sensing is a novel fusion of GPS carrier phase measurements with camera images at the level of the so-called bundle adjustment process that is central to robust visual simultaneous localization and mapping (SLAM). In future work, my technique will attempt joint visual SLAM and carrier integer ambiguity resolution. If I am successful, the result will be a tight fusion of GPS and visual sensing that will be highly trustworthy due to the extraordinary richness and strong keyframe-to-keyframe correlation of the visual data.

My second approach to robust perception extracts navigation and timing information from a large set of heterogeneous terrestrial and satellite signals-of-opportunity—essentially a diversity approach to robustness. The cooperative opportunistic navigation concept is at bottom an exercise in highly agile software-defined radio and in signal landscape SLAM, which differs from traditional landmark-based SLAM in that the landscape is dynamic. I have resolved fundamental questions of joint landscape and receiver state observability, and have built, in collaboration with colleagues at Cornell University, arguably the most capable and sophisticated software-defined multi-system radio that exists. This groundwork provides a launching point for a broader and deeper study of cooperative navigation and timing extraction based on signals of opportunity.

**Research Impact.** My laboratory has produced several publications in robust perception [16, 39–50]; for [45] we were awarded the best student paper award at the 2012 IEEE/ION PLANS conference.

On the basis of our pioneering work in robust perception, my student Zak Kassas was recently hired as an assistant professor at the University of California, Riverside.

Funding for my robust perception research has come from the U.S. Department of Transportation and the Boeing Corporation. My share of total external funding in this area has been \$250k.

## PRECISION POSE FOR CONSUMER MOBILE APPLICATIONS

GPS chipsets are getting smaller, cheaper, and more energy efficient. They are now ubiquitous in smartphones and tablets, enabling a host of location-based services. But the underlying positioning accuracy of consumer-grade GPS receivers has stagnated at approximately 2-3 meters. I am engaged in bringing about the next revolution in consumer-grade mobile positioning, which will take us to centimeter accuracy.

The challenges of cm-accuracy on consumer devices are daunting: (1) The GPS antennas on mobile handsets and tablets are little better than smashed paper clips. Their poor quality (15-20 dB below that of even a cheap patch antenna and dismal multipath mitigation) makes it extremely challenging to extract carrier phase measurements accurate enough for fast fixing of the integer ambiguities that arise in the carrier-phase differential technique. And mobile users are impatient: they may be persuaded to wait 30 seconds for a cm-accurate position fix, but only a resolute few would hold out for longer. (2) Differential carrier-phase-based positioning is power hungry compared with standard code-phase positioning. On a mobile device, milliwatts matter. (3) Lack of a killer app.

I am working on innovations to meet these challenges [51–53]. The most promising of these innovations exploits a mobile device’s camera in a near-optimal combination of visual SLAM and centimeter-accurate carrier phase differential GPS adapted for mobile devices. This combination will produce not only precise precision for mobile devices but a complete and precise pose (position and orientation), which will be a key enabler for convincing mobile augmented reality (AR). I believe that video-see-through AR built on this technology has the potential to become a must-have application for future mobile devices. I have secured \$100k in funding from Samsung Research America for this research.

## INSTRUMENTATION FOR REMOTE SENSING

Radio-frequency navigation and timing signals can be excellent sources of remotely-sensed science data, revealing structural details of the ionosphere and neutral atmosphere. Perhaps the most promising technique is GPS-based radio occultation (GPSRO), which yields electron density and precipitable water vapor or temperature profiles useful for numerical weather prediction (including space weather). Together with colleagues at UT and Cornell University, I have developed the first software-defined GPSRO sensor suitable for deployment on a cubesat [54, 55]. I have also developed an instrument for ionospheric scintillation monitoring [56–58], which leverages my work in software-defined radio [30, 59, 60] and applies techniques I developed for robust GPS signal tracking during scintillation [61–63].

Funding for instrumentation research has come from the AFOSR, NSF, and Lockheed Martin. My share of total external funding in this area has been \$413k.

## REFERENCES

- [1] T. E. Humphreys, B. M. Ledvina, M. L. Psiaki, B. W. O'Hanlon, and P. M. Kintner, Jr., "Assessing the spoofing threat: Development of a portable GPS civilian spoofer," in *Proceedings of the ION GNSS Meeting*, (Savannah, GA), Institute of Navigation, 2008.
- [2] T. E. Humphreys, B. M. Ledvina, M. L. Psiaki, B. W. O'Hanlon, and P. M. Kintner, Jr., "Assessing the spoofing threat," *GPS World*, vol. 20, pp. 28–38, Jan. 2009.
- [3] D. P. Shepard, T. E. Humphreys, and A. A. Fansler, "Evaluation of the vulnerability of phasor measurement units to GPS spoofing attacks," *International Journal of Critical Infrastructure Protection*, vol. 5, no. 3-4, pp. 146–153, 2012.
- [4] D. P. Shepard, J. A. Bhatti, and T. E. Humphreys, "Drone hack: Spoofing attack demonstration on a civilian unmanned aerial vehicle," *GPS World*, Aug. 2012.
- [5] D. P. Shepard, J. A. Bhatti, T. E. Humphreys, and A. A. Fansler, "Evaluation of smart grid and civilian UAV vulnerability to GPS spoofing attacks," in *Proceedings of the ION GNSS Meeting*, 2012.
- [6] A. J. Kerns, D. P. Shepard, J. A. Bhatti, and T. E. Humphreys, "Unmanned aircraft capture and control via GPS spoofing," *Journal of Field Robotics*, vol. 31, no. 4, pp. 617–636, 2014.
- [7] A. H. Rutkin, "Spoofers' use fake GPS signals to knock a yacht off course," *MIT Technology Review*, Aug. 2013.
- [8] J. A. Bhatti and T. E. Humphreys, "Covert control of surface vessels via counterfeit civil GPS signals," 2014. (In preparation; available at <http://radionavlab.ae.utexas.edu/vessels>).
- [9] UT Radionavigation Laboratory, "Research spotlight," July 2014. <http://radionavlab.ae.utexas.edu/spotlight>.
- [10] T. E. Humphreys, "Statement on the vulnerability of civil unmanned aerial vehicles and other systems to civil GPS spoofing." <http://homeland.house.gov/sites/homeland.house.gov/files/Testimony-Humphreys.pdf>, July 2012.
- [11] T. E. Humphreys, "Statement on privacy issues related to the domestic use of unmanned aerial vehicles." <http://radionavlab.ae.utexas.edu/images/stories/files/papers/statementOctober.pdf>, Oct. 2012.
- [12] K. D. Wesson, M. P. Rothlisberger, and T. E. Humphreys, "Practical cryptographic civil GPS signal authentication," *Navigation, Journal of the Institute of Navigation*, vol. 59, no. 3, pp. 177–193, 2012.
- [13] T. E. Humphreys, "Detection strategy for cryptographic GNSS anti-spoofing," *IEEE Transactions on Aerospace and Electronic Systems*, vol. 49, no. 2, pp. 1073–1090, 2013.
- [14] M. Psiaki, B. O'Hanlon, J. Bhatti, D. Shepard, and T. Humphreys, "GPS spoofing detection via dual-receiver correlation of military signals," *IEEE Transactions on Aerospace and Electronic Systems*, vol. 49, no. 4, pp. 2250–2267, 2013.
- [15] B. W. O'Hanlon, M. L. Psiaki, T. E. Humphreys, J. A. Bhatti, and D. P. Shepard, "Real-time GPS spoofing detection via correlation of encrypted signals," *Navigation, Journal of the Institute of Navigation*, vol. 60, no. 4, pp. 267–278, 2013.
- [16] T. E. Humphreys, J. Bhatti, and B. Ledvina, "The GPS Assimilator: a method for upgrading existing GPS user equipment to improve accuracy, robustness, and resistance to spoofing," in *Proceedings of the ION GNSS Meeting*, (Portland, Oregon), Institute of Navigation, 2010.
- [17] B. O'Hanlon, J. Bhatti, T. E. Humphreys, and M. Psiaki, "Real-time spoofing detection in a narrow-band civil GPS receiver," in *Proceedings of the ION GNSS Meeting*, (Portland, Oregon), Institute of Navigation, 2010.
- [18] K. D. Wesson, M. P. Rothlisberger, and T. E. Humphreys, "A proposed navigation message authentication implementation for civil GPS anti-spoofing," in *Proceedings of the ION GNSS Meeting*, (Portland, Oregon), Institute of Navigation, 2011.
- [19] K. D. Wesson, D. P. Shepard, J. A. Bhatti, and T. E. Humphreys, "An evaluation of the vestigial signal defense for civil GPS anti-spoofing," in *Proceedings of the ION GNSS Meeting*, (Portland, OR), 2011.
- [20] M. L. Psiaki, B. W. O'Hanlon, J. A. Bhatti, and T. E. Humphreys, "Civilian GPS spoofing detection based on dual-receiver correlation of military signals," in *Proceedings of the ION GNSS Meeting*, (Portland, Oregon), Institute of Navigation, 2011.

- [21] R. Mitch, R. Dougherty, M. Psiaki, S. Powell, B. O'Hanlon, J. Bhatti, and T. Humphreys, "Signal characteristics of civil GPS jammers," in *Proceedings of the ION GNSS Meeting*, 2011.
- [22] D. Shepard and T. E. Humphreys, "Characterization of receiver response to a spoofing attack," in *Proceedings of the ION GNSS Meeting*, (Portland, Oregon), Institute of Navigation, 2011.
- [23] D. Shepard, T. E. Humphreys, and A. Fansler, "Evaluation of the vulnerability of Phasor Measurement Units to GPS spoofing," in *Sixth Annual IFIP WG 11.10 International Conference on Critical Infrastructure Protection*, (Washington, DC), Mar. 2012.
- [24] J. A. Bhatti, T. E. Humphreys, and B. M. Ledvina, "Development and demonstration of a TDOA-based GNSS interference signal localization system," in *Proceedings of the IEEE/ION PLANS Meeting*, pp. 1209–1220, April 2012.
- [25] T. E. Humphreys, J. A. Bhatti, D. P. Shepard, and K. D. Wesson, "The Texas Spoofing Test Battery: Toward a standard for evaluating GNSS signal authentication techniques," in *Proceedings of the ION GNSS Meeting*, 2012. <http://radionavlab.ae.utexas.edu/texbat>.
- [26] K. D. Wesson, T. E. Humphreys, and B. L. Evans, "Position paper: Secure time transfer for CPS," in *NSF/NSA National Workshop on The New Clockwork for Time-Critical Systems*, 2012.
- [27] K. D. Wesson, B. L. Evans, and T. E. Humphreys, "A combined symmetric difference and power monitoring GNSS anti-spoofing technique," in *IEEE Global Conference on Signal and Information Processing*, 2013.
- [28] K. D. Wesson, B. L. Evans, and T. E. Humphreys, "A probabilistic framework for Global Navigation Satellite System signal timing assurance," in *Proceedings of Asilomar Conference on Signals, Systems, and Computers*, (Pacific Grove, CA), 2013.
- [29] A. J. Kerns, K. D. Wesson, and T. E. Humphreys, "A blueprint for civil GPS navigation message authentication," in *Proceedings of the IEEE/ION PLANS Meeting*, May 2014.
- [30] T. E. Humphreys, D. P. Shepard, J. A. Bhatti, and K. D. Wesson, "A testbed for developing and evaluating GNSS signal authentication techniques," in *Proceedings of the International Symposium on Certification of GNSS Systems and Services (CERGAL)*, (Dresden, Germany), July 2014. (available at <http://radionavlab.ae.utexas.edu/testbed>).
- [31] P. Y. Montgomery, T. E. Humphreys, and B. M. Ledvina, "A multi-antenna defense: Receiver-autonomous GPS spoofing detection," *Inside GNSS*, vol. 4, pp. 40–46, April 2009.
- [32] T. E. Humphreys, J. Bhatti, and B. M. Ledvina, "The GPS Assimilator: Upgrading receivers via benign spoofing," *Inside GNSS*, vol. 5, pp. 50–58, June 2010.
- [33] K. D. Wesson, D. P. Shepard, and T. E. Humphreys, "Straight talk on anti-spoofing: Securing the future of PNT," *GPS World*, Jan. 2012.
- [34] R. Mitch, R. Dougherty, M. Psiaki, S. Powell, B. O'Hanlon, J. Bhatti, and T. E. Humphreys, "Know your enemy: Signal characteristics of civil GPS jammers," *Inside GNSS*, Jan. 2012.
- [35] T. E. Humphreys, "The GPS dot and its discontents: Privacy vs. GNSS integrity," *Inside GNSS*, vol. 7, Mar./Apr. 2012.
- [36] D. P. Shepard, T. E. Humphreys, and A. A. Fansler, "Going up against time: The power grid's vulnerability to GPS spoofing attacks," *GPS World*, Aug. 2012.
- [37] K. D. Wesson and T. E. Humphreys, "Hacking drones," *Scientific American*, vol. 309, no. 5, pp. 54–59, 2013.
- [38] T. E. Humphreys, "How to fool a GPS," Feb. 2012. [http://www.ted.com/talks/todd\\_humphreys\\_how\\_to\\_fool\\_a\\_gps](http://www.ted.com/talks/todd_humphreys_how_to_fool_a_gps).
- [39] Z. M. Kassas and T. E. Humphreys, "Observability analysis of collaborative opportunistic navigation with pseudorange measurements," *IEEE Transactions on Intelligent Transportation Systems*, vol. 15, pp. 260–273, Feb. 2014.
- [40] Z. M. Kassas and T. E. Humphreys, "Receding horizon trajectory optimization in opportunistic navigation environments," *IEEE Transactions on Aerospace and Electronic Systems*, 2014. (To be published.).
- [41] Z. M. Kassas, A. Arapostathis, and T. E. Humphreys, "Greedy motion planning for simultaneous signal landscape mapping and receiver localization," *IEEE Journal of Selected Topics in Signal Processing*, 2014. (In preparation after favorable reviews.).

- [42] K. Wesson, K. Pesyna, J. Bhatti, and T. E. Humphreys, "Opportunistic frequency stability transfer for extending the coherence time of GNSS receiver clocks," in *Proceedings of the ION GNSS Meeting*, (Portland, Oregon), Institute of Navigation, 2010.
- [43] K. M. Pesyna, Jr., K. D. Wesson, R. W. Heath, Jr., and T. E. Humphreys, "Extending the reach of GPS-assisted femtocell synchronization and localization through tightly-coupled opportunistic navigation," in *IEEE GLOBECOM Workshop*, 2011.
- [44] K. Pesyna, Z. Kassas, J. Bhatti, and T. E. Humphreys, "Tightly-coupled opportunistic navigation for deep urban and indoor positioning," in *Proceedings of the ION GNSS Meeting*, (Portland, Oregon), Institute of Navigation, 2011.
- [45] K. M. Pesyna, Z. M. Kassas, and T. E. Humphreys, "Constructing a continuous phase time history from TDMA signals for opportunistic navigation," in *Proceedings of the IEEE/ION PLANS Meeting*, pp. 1209–1220, April 2012.
- [46] Z. M. Kassas and T. E. Humphreys, "Observability analysis of opportunistic navigation with pseudorange measurements," in *Proceedings of AIAA Guidance, Navigation, and Control Conference*, Aug. 2012.
- [47] Z. M. Kassas and T. E. Humphreys, "Observability and estimability of collaborative opportunistic navigation with pseudorange measurements," in *Proceedings of the ION GNSS Meeting*, (Nashville, Tennessee), Institute of Navigation, 2012.
- [48] Z. M. Kassas and T. E. Humphreys, "Motion planning for optimal information gathering in opportunistic navigation systems," in *AIAA Guidance, Navigation, and Control Conference (GNC'13)*, (Boston, MA), pp. 4551–4565, Aug. 2013.
- [49] Z. Kassas, J. A. Bhatti, and T. E. Humphreys, "Receding horizon trajectory optimization for simultaneous signal landscape mapping and receiver localization," in *Proceedings of the ION GNSS+ Meeting*, September 2013.
- [50] Z. Kassas and T. E. Humphreys, "The price of anarchy in active signal landscape map building," in *Proceedings of IEEE Global Conference on Signal and Information Processing*, December 2013.
- [51] D. P. Shepard, K. M. Pesyna, and T. Humphreys, "Precise augmented reality enabled by carrier-phase differential GPS," in *Proceedings of the ION GNSS Meeting*, (Nashville, Tennessee), Institute of Navigation, 2012.
- [52] D. P. Shepard and T. E. Humphreys, "High-precision globally-referenced position and attitude via a fusion of visual SLAM, carrier-phase-based GPS, and inertial measurements," in *Proceedings of the IEEE/ION PLANS Meeting*, May 2014.
- [53] K. Pesyna, Z. Kassas, R. Heath, and T. Humphreys, "A phase-reconstruction technique for low-power centimeter-accurate mobile positioning," *IEEE Transactions on Signal Processing*, vol. 62, pp. 2595–2610, May 2014.
- [54] A. J. Joplin, E. G. Lightsey, and T. E. Humphreys, "Development and testing of a miniaturized, dual-frequency GPS receiver for space applications," in *Proceedings of the ION International Technical Meeting*, (Long Beach, CA), Jan. 2012.
- [55] E. G. Lightsey, T. E. Humphreys, J. A. Bhatti, A. J. Joplin, B. W. OHanlon, and S. P. Powell, "Demonstration of a space capable miniature dual frequency GNSS receiver," *Navigation, Journal of the Institute of Navigation*, vol. 61, no. 1, pp. 53–64, 2014.
- [56] K. B. Deshpande, G. S. Bust, C. R. Clauer, H. Kim, J. E. Macon, T. E. Humphreys, J. A. Bhatti, S. B. Musko, G. Crowley, and A. T. Weatherwax, "Initial GPS scintillation results from CASES receiver at South Pole, Antarctica," *Radio Science*, vol. 47, no. 5, 2012.
- [57] H. Kim, C. Clauer, K. Deshpande, M. Lessard, A. Weatherwax, G. S. Bust, G. Crowley, and T. E. Humphreys, "Ionospheric irregularities during a substorm event: Observations of ULF pulsations and GPS scintillations," *Journal of Atmospheric and Solar-Terrestrial Physics*, vol. 114, pp. 1–8, 2014.
- [58] C. R. Clauer, H. Kim, K. Deshpande, Z. Xu, D. Weimer, S. Musko, G. Crowley, C. Fish, R. Nealy, T. E. Humphreys, J. A. Bhatti, and A. J. Ridley, "Autonomous adaptive low-power instrument platform (AAL-PIP) for remote high latitude geospace data collection," *Geoscientific Instrumentation, Methods and Data Systems*, 2014. (To be published.).

- [59] T. E. Humphreys, J. Bhatti, T. Pany, B. Ledvina, and B. O'Hanlon, "Exploiting multicore technology in software-defined GNSS receivers," in *Proceedings of the ION GNSS Meeting*, (Savannah, GA), pp. 326–338, Institute of Navigation, 2009.
- [60] B. O'Hanlon, M. Psiaki, S. Powell, J. Bhatti, T. E. Humphreys, G. Crowley, and G. Bust, "CASES: A smart, compact GPS software receiver for space weather monitoring," in *Proceedings of the ION GNSS Meeting*, (Portland, Oregon), pp. 2745–2753, Institute of Navigation, 2011.
- [61] T. E. Humphreys, M. L. Psiaki, J. C. Hinks, B. O'Hanlon, and P. M. Kintner, Jr., "Simulating ionosphere-induced scintillation for testing GPS receiver phase tracking loops," *IEEE Journal of Selected Topics in Signal Processing*, vol. 3, pp. 707–715, Aug. 2009.
- [62] T. E. Humphreys, M. L. Psiaki, B. M. Ledvina, A. P. Cerruti, and P. M. Kintner, Jr., "A data-driven testbed for evaluating GPS carrier tracking loops in ionospheric scintillation," *IEEE Transactions on Aerospace and Electronic Systems*, vol. 46, pp. 1609–1623, Oct. 2010.
- [63] T. E. Humphreys, M. L. Psiaki, and P. M. Kintner, Jr., "Modeling the effects of ionospheric scintillation on GPS carrier phase tracking," *IEEE Transactions on Aerospace and Electronic Systems*, vol. 46, pp. 1624–1637, Oct. 2010.

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## Candidate's Statement on Research

**Table 1. Research Summary**

Metric	Value
Peer-Reviewed Journal Publications in Rank	16
Peer Reviewed Conference Proceedings Publications in Rank	34
Total Citations of all Publications (career)*	933
h-index (career)*	19
Google Scholar Total Citations of all Publications (career)	933
Google Scholar h-index (career)	19
Research Funding Raised (total share)	\$4,567,640
Research Funding Raised (candidate share)	\$1,824,640
Total Grants/Contracts Received	14
PI on Grants/Contracts Received	13

**Table 2. External Grants and Contracts Awarded while in Rank**

Note: The table below reflects only funding *external to UT*. From *internal* UT sources, additional funds in the amount of \$185,000 (\$110,000 candidate share) were obtained. These internal funds came from the Wireless Networking and Communications Group and from the UT College of Natural Sciences.

Co-Investigators	Title	Agency	Project Total/	Candidate Share	Grant Period
None	Connected Autonomous Space Environment Sensors (CASES) Phase II STTR	AFOSR via ASTRA LLC	\$224,491	\$224,491	June 2009--March 2011
None	CASES Adaptations for Antarctic Deployment	NSF via. ASTRA LLC	\$120,000	\$120,000	Jan. 2010--Dec. 2011
None	Investigation into GPS jamming detection and localization techniques	Coherent Navigation, Inc.	\$240,000	\$240,000	Sept. 2010--July 2012
None	IGPS technology concept demonstration time and frequency stability transfer model	Boeing	\$120,000	\$120,000	Sept. 2010--Jan. 2012
None	FOTON sensor development	Lockheed Martin	\$69,000	\$69,000	
None	Cyber Critical Infrastructure Protection GPS Timing Proof of Concept	Northrop Grumman	\$65,050	\$65,050	Nov. 2011--Jan. 2012
None	Emitter locator (EMLOC) system for emitter detection and localization---Phase I STTR	U.S. Navy via Coherent Navigation, Inc.	\$34,000	\$34,000	Aug. 2011--Mar. 2012
None	GPS Vulnerability Simulation Support	Sandia Nat. Lab.	\$40,083	\$40,083	July 2012--Nov. 2012
None	Research into UAV Navigation System Vulnerability to Spoofing Attacks	Harris Corp.	\$75,000	\$75,000	Sept. 2012--Aug. 2013
None	Emitter locator (EMLOC) system for emitter detection and localization---Phase II STTR	U.S. Navy via Coherent Navigation, Inc.	\$225,016	\$225,016	April 2013--April 2015
None	GPS Timing Phase II Proof of Concept	DOD (DTRA) via Northrop Grumman	\$150,000	\$150,000	June 2013--April 2014
None	Strengthening GPS Receiver Resistance to Deceptive Civil Signals	US Air Force GPS Directorate	\$120,000	\$120,000	June 2013--June 2015
None	Precise positioning for mobile devices	Samsung Research America	\$100,000	\$100,000	Jan. 2014--Jan. 2015
PI: Chandra Bhat, UT CTR, 8 co-	Data-Supported Transportation Operations and Planning (D-	U.S. Dept. of Transportation	\$2,800,000	\$132,000	Sept. 2013--Sept. 2017

investigators from CTR and WNCG	STOP)				
<b>TOTAL</b>			\$4,382,640	<b>\$1,714,640</b>	

\*Source:

- Publish or Perish (with Google Scholar input)
- ISI Web of Knowledge

## PROJECT DIVISION OF LABOR

TODD HUMPHREYS

### SUMMARY OF TOTAL RESEARCH FUNDS

	External	Internal	Total
Career total:	\$4,382,640	\$185,000	\$4,567,640
Humphreys share career:	\$1,714,640	\$110,000	\$1,824,640
In-rank total:	\$4,382,640	\$185,000	\$4,567,640
Humphreys share in rank:	\$1,714,640	\$110,000	\$1,824,640

### INDIVIDUAL PROJECTS

For all projects listed in this section, whose funds total \$1.7M, I was principal investigator at UT and all funds were directed to my laboratory.

- \$100,000, Jan. 2014–Jan. 2015, “Precise positioning for mobile devices,” Samsung Research America.
- \$120,000, June 2013–June 2015, “Strengthening GPS Receiver Resistance to Deceptive Civil Signals,” U.S. Air Force GPS Directorate, NAVSEA/NGA.
- \$23,000, June 2013–June 2014, “Communication and Location Research,” gift funding from the UT Wireless Networking and Communications Group.
- \$150,000, June 2013–April 2014, “GPS Timing Phase II Proof of Concept,” U.S. Defense Threat Reduction Agency via Northrop Grumman Corp.
- \$225,016, April 2013–April 2015, “Emitter locator (EMLOC) system for emitter detection and localization—Phase II,” U.S. Navy via Coherent Navigation.
- \$36,000, Sept. 2012–Dec. 2013, “Cooperative Opportunistic Navigation Research,” gift funding from NSF WiCAT Center, UT Wireless Networking and Communications Group.
- \$75,000, Sept. 2012–Aug. 2013, “Research into UAV Navigation System Vulnerability to Spoofing Attacks,” Harris Corp.
- \$20,000, June 2012–June 2013, “Communication and Location Research,” gift funding from the UT Wireless Networking and Communications Group.
- \$40,083, July 2012–Nov. 2012, “GPS Vulnerability Simulation Support,” Sandia National Laboratory.
- \$23,000, June 2011–June 2012, “Communication and Location Research,” gift funding from the UT Wireless Networking and Communications Group.

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*Date:* August 13, 2014.

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- \$34,000, Aug. 2011–Mar. 2012, “Emitter locator (EMLOC) system for emitter detection and localization—Phase I,” U.S. Navy via Coherent Navigation.
- \$65,050, Nov. 2011–Jan. 2012, “Cyber Critical Infrastructure Protection GPS Timing Proof of Concept,” Northrop Grumman Corp.
- \$69,000, Nov. 2010–Jan. 2011, “FOTON sensor development,” Lockheed Martin Corp.
- \$120,000, Sept. 2010–Jan. 2012, “IGPS technology concept demonstration time and frequency stability transfer model,” The Boeing Company.
- \$8,000, June 2010–June 2011, “Communication and Location Research,” gift funding from the UT Wireless Networking and Communications Group.
- \$240,000<sup>1</sup>, Sept. 2010–July 2012, “Investigation into GPS jamming detection and localization techniques,” Coherent Navigation, Inc.
- \$120,000, Jan. 2010–Dec. 2011, “CASES Adaptations for Antarctic Deployment,” National Science Foundation via ASTRA Space LLC.
- \$224,491, June 2009–March 2011, “Connected Autonomous Space Environment Sensors (CASES),” U.S. Air Force Office of Sponsored Research via ASTRA Space LLC.

#### JOINT PROJECTS

The division of labor for the following joint projects is detailed with each project description. Humphreys's share of the total funding was \$132k.

- \$2,800,000 (total); \$132,000 (Humphreys), Sept. 2013–Sept. 2017, “Data-Supported Transportation Operations and Planning (D-STOP),” U.S. Department of Transportation. Principal Investigator: Chandra Bhat, UT Center for Transportation Research. Co-Investigators: A total of 8 faculty from the UT Wireless Communications and Networking Group and the UT Center for Transportation Research. Humphreys's \$132k share represents approximately 5% of the award. Humphreys is tasked with developing techniques for secure vehicle-to-vehicle and vehicle-to-infrastructure communications and improved safety based on mobility trace analysis.
- \$75,000 (total); \$0 (Humphreys), May 2014–May 2015, “Development of Transformative Tracking and Mapping Instrumentation for Tracking, Mapping and Identifying Camouflage and Navigation Strategies in Dynamic, Complex Environments,” UT College of Natural Sciences Catalyst Grant Competition. Principal Investigator: Molly Cummings, Integrative Biology. The entire \$75k award has been directed to Cummings's post-graduate researcher, who will aid Cummings and Humphreys in writing large externally-funded proposals.

#### REFERENCES

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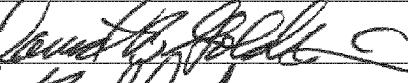
<sup>1</sup>Award was reduced to less than this amount before the end of the project period.

**Budget Council Assessment of Academic Advising, Counseling and Other Student Services  
for Dr. Todd Humphreys**

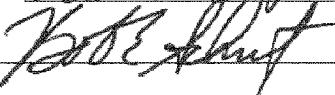
Prepared by: Leszek Demkowicz



David Goldstein



Bob Schutz



The subcommittee, consisting of Professors Demkowicz, Goldstein and Schutz, reviewed documents provided by the candidate (the CV, Advising Statements, etc.) and external letters of reference. Comparisons were made to other ASE/EM faculty at similar stages in their careers.

Most of Dr. Humphreys' academic advising has been of his own cohort of undergraduate and graduate students. At UT he has supervised to completion two PhD dissertations (Kassas, now an Asst. Prof at UC Riverside and Wesson, now at Zeta Assoc.). Both of these were co-supervised with faculty in ECE although Dr. Humphreys was the primary supervisor. This rate of graduation (at least one in rank before promotion) is good. He has also co-supervised a MS report and a MS thesis and has served on the dissertation committees of ten students. He currently has three PhD students in candidacy working with him (one co-supervised) and two additional MS students in progress who aim to continue on to a PhD. He has engaged a new grad student to start this fall. This student too is from an EE background. Moreover, he has supervised three undergraduate students, two of whom have or will soon complete an honors thesis.

Dr. Humphreys' student advising has been strong and he has a continuing steady stream of students moving through his laboratory.

## STATEMENT ON ADVISING

TODD HUMPHREYS

### UNDERGRADUATE LEVEL

I have supervised three undergraduate research assistants, two of whom have completed (Daniel Shepard) or are on track to complete (Deep Mukherji) an undergraduate honors thesis in Aerospace Engineering.

### GRADUATE LEVEL

I was primary supervisor for two students who have completed their Ph.D. at UT:

- Z. M. Kassas, *Analysis and Synthesis of Collaborative Opportunistic Navigation Systems*. PhD thesis, The University of Texas at Austin, May 2014. Co-supervisor: Aristotle Arapostathis (ECE).
- K. Wesson, *Secure Navigation And Timing Without Local Storage Of Secret Keys*. PhD thesis, The University of Texas at Austin, May 2014. Co-supervisor: Brian Evans (ECE).

On the strength of his research under my supervision, *Zak Kassas has obtained a faculty position as assistant professor in the Department of Electrical Engineering at the University of California, Riverside*. Kyle Wesson is also well-placed as a senior researcher at Zeta Associates, an intelligence and defense contractor.

The inter-disciplinary nature of my research encourages co-advising. Accordingly, both Kassas and Kyle, as well as a third student due to graduate next year, Ken Pesyna, have been co-advised with professors in the UT ECE department. But although the Cockrell school promotion summary tables suggest a default 50/50 split to co-advising, it is more accurate to characterize my role in all three co-advising cases as *primary supervisor*: the Ph.D. students' offices were next to mine, we worked together daily, and I played the leading day-to-day role in guiding and evaluating their work.

I am currently supervising 5 Ph.D.-track graduate students.

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Date: July 28, 2014.

I have co-supervised the following masters theses:

- A. J. Joplin, "Development and testing of a miniaturized, dual-frequency, software-defined GPS receiver for space applications," Master's thesis, The University of Texas at Austin, Dec. 2011. Current position: Research staff, Applied Research Laboratories. Primary supervisor: Glenn Lightsey; Co-supervisor: Humphreys.
- M. W. Bright, "GPS L2C signal survey and the development of the emergent MATLAB L2C (EMAL2) receiver," master's report, The University of Texas at Austin, Aug. 2012. Current position: Technical staff, John Deere Intelligent Solutions Group. Primary supervisor: Humphreys; Co-supervisor: Bob Schutz.

I have served on the Ph.D. defense committees of the following students:

Kien Trung Truong, Kumar Appaiah, Thomas Novlan, Vidur Bhargava, Drew Jones, Jaegan Ko, Jing Lin, Chao Jia, Yezhou Wang, Noah Smith

I have served on the Ph.D. qualifying committees of the following students:

Kien Trung Truong, Kumar Appaiah, Thomas Novlan, Vidur Bhargava, Ehab Hussein Hassan, Yousof Mortazavi, Drew Jones, Jaegan Ko, Jing Lin, Chao Jia, Yezhou Wang

I have served on the M.S. report committee of the following student:

Constance McDaniel Wyman

THE UNIVERSITY OF TEXAS AT AUSTIN

*E-mail address:* todd.humphreys@mail.utexas.edu

## Candidate's Statement on Advising, Counseling and Other Student Services

**Table 1. Summary of Academic Advising**

Metric	Value
Student Organizations Advised	1 (AIAA Student Org.)
Undergraduates Supervised	3
PhD Students Completed *	1 (0 sole advisor)
MS Students Completed*	1 (0 sole advisor)
PhD Students in Pipeline (as of 09/2014)*	5 (4 sole advisor)
MS Students in Pipeline (as of 09/2014)*	0 (0 sole advisor)

\*count 1 if sole advisor, 0.5 if co-advised

**Table 2. List of Completed Graduate Students under My Supervision**

Student	Co-Supervisor	Degree	Start Date	Dissertation/ MS Thesis Date	Placement
Kyle Wesson	Brian Evan	Ph.D.	09/2009	05/2014	Zeta Associates
Zaher Kassas	Ari Arapostathis	Ph.D	01/2011	05/2014	ECE Faculty at University of California, Riverside

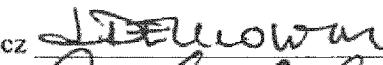
Post-doctoral fellows supervised: None.

Budget Council Assessment of Service Activity for Dr. Todd Humphreys

Prepared by: Leszek Demkowicz

David Goldstein

Bob Schutz




The subcommittee, consisting of Professors Demkowicz, Goldstein and Schutz, reviewed documents provided by the candidate (the CV, Service Statements) and external letters of reference. Comparisons were made to other ASE/EM faculty at similar stages in their careers.

Humphreys has engaged in an extraordinary level of service activity for an Assistant Professor. Within the Department, he is Director of the Radionavigation Lab he established and is faculty advisor to the AIAA student chapter (2010+), and has served on the Orbita area faculty committee and the ASE and ECE Graduate Studies Committees. At the College level he served on the CSE Honors Committee (2011+) and the Faculty Committee. As noted in unsolicited letters by Profs. Heath (Director of the Wireless Networking and Communications Group) and Prof. Tewfik, Chairman of EE, Dr. Humphreys has been a critical and active member in many Group activities, particularly through his industrial interactions with Samsung Electronics and his organization of the Texas Wireless Summit.

Most of Dr. Humphreys' service has occurred outside of The University. He recently was asked to become the editor of IEEE transactions of Wireless Communications (2014+). He has been the Land Representative for the Institute of Navigation Governing Council (2012-2013). He was Lead Organizer of two meetings: in 2013 the Texas Wireless Summit with 240 participants and the 2010 experts meeting on Civil GPS Security. In fact, Dr. Humphreys has taken on a national leadership role in the area of GPS and wireless security. He has twice provided congressional testimony on drone security and privacy in the age of drones – once to the House Subcommittee on Homeland Security Oversight (7/2012), and to the House Judiciary Subcommittee on Crime, Terrorism and Homeland Security (10/2012). His advice has similarly been sought out as an invited subject matter expert by: The Department of Homeland Security in its risk assessment of critical infrastructure dependence on GPS (2011), the USPTO on advances in GNSS (2011), and the National Executive Committee on Position Navigation and Timing (2010). He has also provided guidance to the CIA and the GPS Directorate of the Air Force on civil vulnerability to GPS deception.

Dr. Humphreys' public outreach has been impressive. As a result of notoriety he received for some of his experiments on spoofing of GPS he has been interviewed by at least 9 mass media outlets. He has given a TED talk (a remarkably influential forum) on location security and privacy that has received nearly 600,000 downloads. And he has discussed UAVs, privacy and

navigation security at the SXSW conference three times. He has also brought the issues of GPS security to public attention through the popular science literature such as his 2013 article in *Scientific American* and to industry through publications in *GPS World* and *Inside GNSS*, industry trade publications.

At major conferences he has served as Track chair of the Technical Program Committee (ION GNSS+ Conference, 2013) and session chair or panel session chair at six other conferences.

Altogether, and as affirmed by the external reviewers, this service demonstrates exceptional highly visible leadership in his field and greatly enhances his own reputation and that of the Department, the College and The University.

## STATEMENT ON SERVICE

TODD HUMPHREYS

### INTERNAL SERVICE

I have served since arriving at UT as the founder and director of the UT Radionavigation Laboratory, which is now internationally recognized as a leading research center in navigation and timing security and robustness. I have also served since 2010 as the faculty advisor for the UT student chapter of the AIAA, and since 2011 on the Cockrell school honors committee.

### EXTERNAL SERVICE

Facing outward from UT, my service efforts have been more significant. Since 2010 I have been engaged in vigorous government service and public education.

**Government Service.** In July 2012, I offered testimony before the U.S. Congress regarding unmanned aerial vehicle (UAV) security [1]. The invitation to testify was prompted by my lab's June 2012 demonstration for the U.S. Department of Homeland Security of a successful hacking attack on a small rotorcraft UAV. The demonstration drew worldwide attention and prompted the FAA to initiate a formal study, called the GIISST study, of aircraft vulnerability to GPS deception. Later in 2012, I was invited to offer testimony before a U.S. congressional field forum on the issue of privacy in an age of drones [2].

In October 2010, I was invited to speak before the advisory board to the PNT ExCom, the deputy-secretary-level committee charged with overseeing position, navigation, and timing for the U.S. I encouraged the board to formally investigate national infrastructure vulnerability to GPS disruption and deception. The following month, the advisory board made the same recommendation to the PNT ExCom, resulting in a 9-month National Risk Assessment, conducted by the DHS, in which I also served as a subject matter expert. I later contributed to two follow-on reports by the Government Accountability Office.

On the heels of this government outreach, I was invited to the Central Intelligence Agency and later to the GPS Directorate of the U.S. Air Force to offer guidance on how civil vulnerability to GPS deception should be addressed. The GPS Directorate subsequently put my lab under contract to craft a blueprint for securing civil GPS signals by modulating the broadcast signals with specialized digital signatures. If our blueprint is ultimately implemented, our lab's research will have directly benefited billions of GPS users across the globe.

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*Date:* July 28, 2014.

At the state level, I directly contributed to Texas House Bill 912, which protects privacy by setting limits on public and private use of drones.

**Public Education.** Massive public education has been the centerpiece of my laboratory's outreach strategy. My TED talk on location security and privacy has nearly 600k views [3] and I have spoken to millions on security- and privacy-related topics through mass media outlets such as NPR, BBC, PBS, CBS, CNN, FOX, ABC, CSPAN, and The New York Times [4]. I have also spoken on UAVs, privacy, and navigation security in panel sessions at the popular SXSW conference (twice in 2013 and once in 2014).

**Symposia.** In September, 2012, I convened and hosted a one-day conference on GPS security which attracted 22 attendees from research institutions, government labs, and industry partners including the DLR, MITRE, Cornell, Stanford, UT:ARL, AAAS, and the CIA. Though small, this conference positioned our lab at center of GPS security for years to come. I later led the organization of the 2013 Texas Wireless Summit at UT, which drew 240 attendees from academia, industry, and government.

**Professional Service.** In 2014 I was invited to serve as editor of the IEEE Transactions on Wireless Communications. With an h<sub>5</sub>-index of 82 (Google Metrics), TWC is among the 5 highest-impact IEEE journals. Within the Institute of Navigation (ION), I have served on the executive committee as land representative (2013-present), track chair (2013), session chair (every September meeting and PLANS meeting from 2010-present), and plenary speaker (upcoming in September 2014).

## REFERENCES

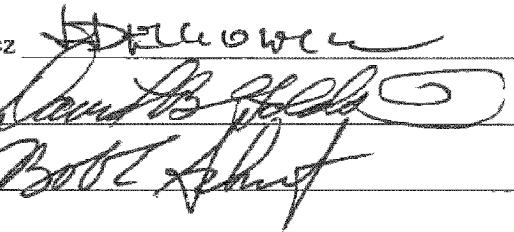
- [1] T. E. Humphreys, "Statement on the vulnerability of civil unmanned aerial vehicles and other systems to civil GPS spoofing." <http://homeland.house.gov/sites/homeland.house.gov/files/Testimony-Humphreys.pdf>, July 2012.
- [2] T. E. Humphreys, "Statement on privacy issues related to the domestic use of unmanned aerial vehicles." <http://radionavlab.ae.utexas.edu/images/stories/files/papers/statementOctober.pdf>, Oct. 2012.
- [3] T. E. Humphreys, "How to fool a GPS," Feb. 2012. [http://www.ted.com/talks/todd\\_humphreys\\_how\\_to\\_fool\\_a\\_gps](http://www.ted.com/talks/todd_humphreys_how_to_fool_a_gps).
- [4] T. R. Laboratory, "Research spotlight," July 2014. <http://radionavlab.ae.utexas.edu/spotlight>.

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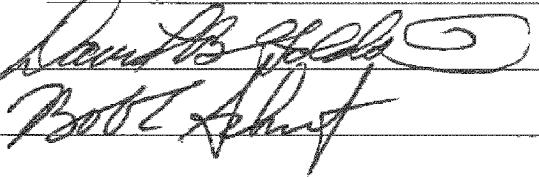
*E-mail address:* todd.humphreys@mail.utexas.edu

**Budget Council Assessment of Honors for Dr. Todd Humphreys**

Prepared by: Leszek Demkowicz



David Goldstein



Bob Schutz



The subcommittee, consisting of Professors Demkowicz, Goldstein and Schutz, reviewed documents provided by the candidate (the CV, Advising Statements, etc.) and external letters of reference. Comparisons were made to other ASE/EM faculty at similar stages in their careers.

Dr. Humphreys has received several awards in his time as Assistant Professor. He has recently been invited to be editor of *IEEE Transactions on Wireless Communications*, he received the GPS World Magazine Leadership Award based on his research impact (GPS World is an industry trade publication), he and his graduate students have won awards at the IEEE/ION PLANS Conference (2012) for Student Best Paper and Overall Paper, and perhaps most significantly, he has won two remarkable teaching awards: In 2012 he won both the University of Texas System Regents' Outstanding Teaching Award and the Cockrell School Dean's Award for Outstanding Teaching by an Assistant Professor. As will be discussed in his Teaching Assessment, these awards are well deserved for his exemplary teaching. It is quite unusual for an Assistant Professor to win both of these awards and to win them so early in his time here at UT.

We also view Honors to include prestigious invitations to speak at notable gatherings. Dr. Humphreys has been invited to provide three Keynote Presentations (two of them in the United Kingdom suggesting an international presence) as well as to various US governmental bodies including testimony before congress (twice), the Air Force, DHS, the CIA, ONR and for public visibility at the SXSW meeting and for a TED talk. This number of invited presentations is very strong for an Associate Professor.

Together, the Honors Prof. Humphreys has received are substantial and in excess of what is common for Assistant Professors.

**STATEMENT ON HONORS AND OTHER EVIDENCE OF MERIT OR  
RECOGNITION, INCLUDING CONTRACTS AND GRANTS**

TODD HUMPHREYS

**RESEARCH HONORS**

**National Awards.**

I lack a national-level research award such as the NSF CAREER award, for which I have applied twice. My 2013 CAREER proposal got respectable reviews (V, V/G, V/G) but was ultimately declined. My 2014 proposal, which is now under consideration, is stronger, and I am hopeful that it will be funded.

**Society Awards.**

I was nominated in 2010 for Institute of Navigation (ION) Early Achievement Award. My case was fairly strong but I was not selected.

I was nominated in 2013 for the ION Thurlow Award, again with a strong case. I was not selected but I believe there is a good chance I'll be nominated and granted the award next year.

I was nominated and later elected to serve on the 11-member ION governing council in 2013 as "Land Representative," a position I still hold.

In 2012, the trade magazine that serves our community, GPS World, began offering a yearly leadership award. Four awardees were chosen by their peers based on research impact. I was selected for the inaugural leadership award in the signals area.

In 2014 I was invited to serve as editor of the IEEE Transactions on Wireless Communications. With an h5-index of 82 (Google Metrics), TWC is among the 5 highest-impact IEEE journals.

**Competitive Funding Awards.**

I discuss above my efforts on the NSF CAREER award.

Together with partners in industry, I won two STTR awards from the Department of Defense, Phase I and Phase II. I was PI on both awards. These awards were fairly competitive but not peer-reviewed.

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*Date:* July 29, 2014.

In 2013, I and 8 other faculty were awarded a highly competitive Department of Transportation grant titled “Data-Supported Transportation Operations and Planning (D-STOP).” Chandra Bhat from the UT Center for Transportation Research is the PI on this grant. My share represents 5% of the total award.

All other funding I have received has been non-competitive; nonetheless, it is somewhat unusual in that in each case the industry or government sponsor *sought out* my laboratory for the research based on the reputation for specialized knowledge that my lab has developed.

#### **Invitations to Speak: Keynote Presentations.**

March 6, 2014, “Secure Perception for Autonomous Systems,” Cornell Sibley Graduate Research Symposium, Ithaca, NY.

February 13, 2013, “Secure Navigation and Timing,” Royal Institute of Navigation Interference Conference, Teddington, UK.

February 22, 2012, “PVT Security: Privacy and Trustworthiness,” Royal Institute of Navigation Conference on GNSS Vulnerability: Present Dangers, Future Threats 2012, Teddington, UK.

#### **Invitations to Speak: Other Notable Presentations.**

March 13, 2014, “Secure Perception for Autonomous Systems,” University of Illinois at Urbana-Champaign, Urbana, IL.

March 7, 2014, “Location Deception,” SXSW Interactive, Austin, TX.

March 8, 2013, “Extreme GPS,” SXSW Interactive, Austin, TX.

February 7, 2013, “GPS Vulnerabilities and Implications for Telecom, international webinar sponsored by ATIS, a leading standards body for telecom.

December 5, 2012, “Navigation and Timing Security,” U.S. Air Force GPS Directorate, Los Angeles, CA.

October 25, 2012, “Privacy Issues Related to the Domestic Use of Unmanned Aerial Vehicles,” statement to the U.S. House Judiciary Subcommittee on Crime, Terrorism, and Homeland Security field forum, Houston, TX.

September 10, 2012, “Secure Civil Navigation and Timing,” Aerospace Corporation research seminar, virtual from Austin, TX.

July 20, 2012, “Secure Civil Navigation and Timing,” MITRE corporation and government customers, McLean, VA.

July 19, 2012, “Radionavigation Robustness and Security,” Office of Naval Research, Arlington, VA.

July 19, 2012, “The vulnerability of civil unmanned aerial vehicles and other systems to civil GPS spoofing,” U.S. House Subcommittee on Homeland Security Oversight hearing on drone security, Washington, DC.

February 11, 2012, “How to fool a GPS,” (invited) TEDxAustin, Austin, TX. Video available at [http://www.ted.com/talks/todd\\_humphreys\\_how\\_to\\_fool\\_a\\_gps](http://www.ted.com/talks/todd_humphreys_how_to_fool_a_gps).

#### TEACHING HONORS

In August 2012 I was awarded the Regents’ teaching award—the most prestigious teaching award offered throughout the University of Texas system. Later that year I was recognized with the Cockrell School dean’s award for outstanding teaching by an assistant professor.

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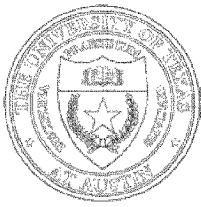
*E-mail address:* todd.humphreys@mail.utexas.edu

**Chart of External Reviewers**  
**Todd Humphreys**  
**Aerospace Engineering and Engineering Mechanics**

Name	Title	Institution	Chosen By Candidate/BC	Date Received	Reason for Declination
<b>RECEIVED</b>					
Axellrad, Penina	Professor and Chair	University of Colorado Boulder	BC	8/1/2014	
Eng, Per	Professor, NAE	Stanford	Candidate	8/21/2014	
Farrell, Jay	Professor	University of California Riverside	Candidate	7/14/2014	
Kamalabadi, Farzad	Professor	University of Illinois at Urbana-Champaign	Candidate	8/6/2014	
Lachapelle, Gerard	Professor	University of Calgary	BC	7/10/2014	
Langley, Richard	Professor	University of New Brunswick	Candidate	8/21/2014	
Marton, Yu (Jade)	Professor	Miami University	Candidate	7/26/2014	
Pervan, Boris	Professor	Illinois Institute of Technology	BC	7/27/2014	
Rizos, Chris	Professor	University of New South Wales	BC	7/18/2014	
Young, Larry	Supervisor	Jet Propulsion Laboratory	Candidate	7/25/2014	
					Dr. Young has developed radiometric technology at JPL since 1978. He has published 36 refereed papers, more than 59 conference proceedings, and 30 NASA tech briefs. He holds 6 US patents.

Chart of External Reviewers  
Todd Humphreys  
Aerospace Engineering and Engineering Mechanics

DECLINED			
Brezinska, Dorota		Ohio State University	BC
NO RESPONSE			6/23/2014 too many other commitments
Parkinson, Bradford	Stanford		BC



AEROSPACE ENGINEERING & ENGINEERING MECHANICS  
THE UNIVERSITY OF TEXAS AT AUSTIN

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210 E. 24<sup>th</sup> St. Stop C0600 · Austin, Texas 78712-1221 · Tel: 512-471-7593 · Fax: 512-471-3788  
[www.ae.utexas.edu](http://www.ae.utexas.edu)

June 13, 2014

Insert Address 1

Insert Address 2

Insert Address 3

Dear Dr. \_\_\_\_\_:

The Department of Aerospace Engineering and Engineering Mechanics is considering Todd Humphreys for tenure and advancement in rank to the position of Associate Professor at the University of Texas at Austin. We would appreciate your candid assessment of his scholarly contributions to assist our decision-making process. Excellent teaching is an important criterion for promotion, but our evaluation of teaching is being carried out separately, and we are asking you only for information about his scholarly distinction. Copies of Dr. Humphreys' curriculum vitae and several recent papers are enclosed for your review.

We would appreciate your opinions regarding Dr. Humphreys' major engineering and/or scientific contributions. In preparing your assessment, please consider the following questions:

1. Do you know Dr. Humphreys, and if so, for how long and under what circumstances?
2. What are the original, innovative, and/or important contributions that he has made in his field of research? Have his publications influenced the thinking of, or the methods used by, others in your field?
3. How would you assess Dr. Humphreys' development compared with others in his cohort at research-intensive universities?
4. What is your perspective on Dr. Humphreys' promise for further professional growth and leadership?

We would be grateful for any additional comments you might have. The more specific you can be in your comments, the more helpful your evaluation will be.

Under the laws of the State of Texas, Dr. Humphreys has the right to request to see any materials in his personnel file, including your letter. Members of our faculty and internal review committees who see your letter as part of the promotion process will hold the comments you make in confidence, however.

For your comments to receive full consideration, we will need to receive a signed letter from you no later than July 28, 2014. It is not necessary for you to send us a hard copy of your letter as an electronic or scanned version is sufficient. However, we would appreciate receiving a copy that includes your institutional letterhead. In addition, please enclose a copy of a short version of your curriculum vitae or résumé (preferably no longer than two pages) or the URL for your Web site where we may obtain this information. If you have questions, please call me at the number given on the letterhead.

We thank you for your time and assistance with this important matter. As faculty members, we realize that the amount of time required to do a thoughtful review is considerable.

Very truly yours,



Noel T. Clemens

Department Chair and Bob R. Dorsey Professor in Engineering

Enclosures

**Five Most Significant Works**  
**Todd Humphreys**

1. Humphreys, T. E., "Detection Strategy for Cryptographic GNSS Anti-Spoofing," *IEEE Transactions on Aerospace and Electronic Systems*, vol. 49, no. 2, pp. 1073--1090, 2013.
2. Kassas, Z. M. and Humphreys, T. E., "Observability Analysis of Collaborative Opportunistic Navigation with Pseudorange Measurements," *IEEE Transactions on Intelligent Transportation Systems*, vol 15, pp. 260 – 273, Feb. 2014.
3. Pesyna, K.M., Z.M. Kassas, R.W. Heath, and T.E. Humphreys, "A Phase-Reconstruction Technique for Low-Power Centimeter-Accurate Mobile Positioning," *IEEE Transactions on Signal Processing*, vol. 62, pp. 2595 – 2610, May 2014.
4. Wesson, K., Rothlisberger, M., and Humphreys, T. E., "Practical Cryptographic Civil GPS Signal Authentication," *NAVIGATION, Journal of the Institute of Navigation*, vol. 59, no. 3, pp. 177--193, 2012.
5. Kerns, A. J., D. P. Shepard, J. A. Bhatti, and T. E. Humphreys, "Unmanned aircraft capture and control via GPS spoofing," *Journal of Field Robotics*, vol. 31, no. 4, pp. 617 – 636, 2014.



Aerospace Engineering Sciences  
UNIVERSITY OF COLORADO BOULDER

Penina Axelrad  
Engineering Center, ECOT 634  
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penina.axelrad@colorado.edu

July 31, 2014

Dr. Noel T. Clemens  
Department Chair and Bob R. Dorsey Professor in Engineering  
Aerospace Engineering & Engineering Mechanics  
The University of Texas at Austin  
210 E. 24<sup>th</sup> St. Stop C0600  
Austin, Texas 78712-1221

Dear Professor Clemens:

I am pleased to provide an evaluation of the scholarly contributions of Dr. Todd Humphreys in support of your review for his tenure and advancement to the rank of Associate Professor. He is a bold and highly skilled researcher who has clearly demonstrated the ability to be successful in a top tier research university.

My responses to your specific questions are as follows.

*Do you know Dr. Humphreys, and if so, for how long and under what circumstances?*

I have known Todd Humphreys since he was a graduate student at Cornell through our mutual participation in the Institute of Navigation. I keep up with his publications and conference presentations, but have not formally collaborated with him on any projects.

*What are the original, innovative, and/or important contributions that he has made in his field of research? Have his publications influenced the thinking of, or the methods used by, others in your field?*  
Dr. Humphreys' most important contributions thus far are in the areas of GPS security and signal tracking in the presence of scintillation. His influence on the field of GPS security is quite remarkable for a faculty member at such an early stage in his career. Dr. Humphreys has published **the most highly cited articles** describing the threat spoofing to GPS use and innovative detection strategies to insure the validity of position and timing solutions. He is widely recognized and his work highly valued because he has addressed this important issue through both analytical developments and experimental demonstrations. His work on modeling the impact of scintillation on GPS signals, especially the severe variations that occur in the equatorial region, is widely used by researchers looking to develop robust tracking methods for use in studying ionospheric effects and for standard position, navigation, and timing solutions under challenging atmospheric conditions. I expect that his work on both topics has already directly impacted the design of experimental and commercial receiver software.

*How would you assess Dr. Humphreys' development compared with others in his cohort at research-intensive universities?*

In terms of productivity and quality of work, I would put Dr. Humphreys among the very top faculty members in the GNSS area at a similar point in their careers. He has been very effective in identifying a set of critically important research topics and establishing himself as a leading contributor. These topics certainly build upon his graduate work, but have also clearly moved into new areas thus demonstrating his ability to recognize problems that are rich in research opportunities and his technical capacity to solve

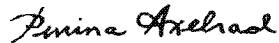
challenging problems. His ability to capitalize on this is demonstrated through his success in garnering substantial external funding and his strong publication record.

*What is your perspective on Dr. Humphreys' promise for further professional growth and leadership?*  
It is clear from his scholarly progress thus far, and the high level of engagement and leadership he already has in the GNSS community, that Dr. Humphreys has great promise to be a significant contributor and thought leader in the future. His ability and willingness to address and explain critical issues from both a technical and layman's perspective puts him squarely in a fairly small class of researchers who can be expected to effectively advance the field with broad based support. I am also quite impressed with his very recent work in collaboration with his PhD student Z.M. Kassas on opportunistic navigation. I believe that this will be yet another area for future growth and leadership in the field.

In summary, Professor Humphreys' scholarly record is extremely strong, certainly of the caliber worthy of tenure and promotion to Associate Professor at my university. I congratulate you on his development as a faculty member and look forward to seeing his future contributions to the field.

Please feel free to contact me should you have any questions.

Sincerely,



Penina Axelrad, Professor and Chair, Aerospace Engineering Sciences

**Gonzales, Laurie**

---

**From:** Penina Axelrad <penina.axelrad@Colorado.EDU>  
**Sent:** Friday, August 01, 2014 10:32 AM  
**To:** Gonzales, Laurie  
**Cc:** Penina Axelrad  
**Subject:** Re: External Review Request - Todd Humphreys  
**Attachments:** PA-14-07-31 Humphreys P&T Letter.pdf; ATT00001.htm; PA-14-07-31 Axelrad 2-page Vita.pdf; ATT00002.htm

## **PENINA AXELRAD**

Colorado Center for Astrodynamics Research  
 Department of Aerospace Engineering Sciences  
 University of Colorado, UCB 431, Boulder, CO 80309-0431  
 Office (303) 492-8183, Fax (303) 492-2825  
 email : Penina.Axelrad@Colorado.EDU

### **Research Interests**

Global Positioning System (GPS) and Global Navigation Satellite System (GNSS) technology and applications for satellite orbit and attitude determination, passive orbit estimation and relative navigation, GNSS reflections and occultations for remote sensing; GNSS multipath characterization and mitigation; space situational awareness and estimation methods.

### **Education**

Ph.D. in Aeronautics and Astronautics, 1991, Stanford University, Stanford, CA

Dissertation: "A Closed-Loop GPS-Based Orbit Trim System for Gravity Probe B."

S.M. in Aeronautical and Astronautical Engineering, 1986, Massachusetts Institute of Technology, Cambridge, MA, Master's thesis: "Near-Earth Orbit Determination and Rendezvous Navigation Using GPS."

S.B. in Aeronautical and Astronautical Engineering (Avionics Option), 1985, Massachusetts Institute of Technology, Cambridge, MA.

### **Professional Experience**

2012- present, Chair, Department of Aerospace Engineering Sciences, University of Colorado Boulder

2005- present, Professor, (1999-2005) Assoc Professor, (1992-1999) Assist Professor, Department of Aerospace Engineering Sciences, Colorado Center for Astrodynamics Research, University of Colorado, Boulder

2008- 2009 Visiting Scientist COSMIC Program Office, UCAR

1990 – 1992 Member of Technical Staff, Stanford Telecom, Inc, Santa Clara, CA

1991-1992 Lecturer, Department of Aeronautics and Astronautics, Stanford University.

1990-1992 Member of the Technical Staff and Program Manager, GPS Systems Organization, Stanford Telecommunications Inc., Santa Clara, CA.

1986-1990 Graduate Research Assistant, Gravity Probe B, Stanford University.

1985-1986 Systems Engineer, Space and Communications Group, Hughes Aircraft Co., El Segundo, CA.

### **Honors and Awards (Selected)**

Institute of Navigation Samuel Burka Award (2012)

American Institute of Aeronautics and Astronautics Summerfield Book Award (2011)

University of Colorado, College of Engineering and Applied Science, Max S. Peters Faculty Service Award (2009)

Institute of Navigation Johannes Kepler Award (2009)

Fellow, American Institute of Aeronautics and Astronautics (2008)

Institute of Navigation Outstanding Service Award (2005)

Fellow, Institute of Navigation (2004)

University of Colorado, Subaru Educator Spotlight (2004)

Senior Member, Institute of Electrical and Electronics Engineers (2003)

Institute of Navigation Tycho Brahe Award (2003)

AIAA Lawrence Sperry Award (1996)

AAS/AIAA Space Flight Mechanics Meeting Best Paper Award (1996)

Member Sigma Xi and Tau Beta Pi

### **Professional and Service Activities (Selected)**

2013-2015	National Space-Based Positioning, Navigation and Timing (PNT) Advisory Board
2012-Present	CU AeroSpace Ventures Executive Committee
2002-2012	Member of the Massachusetts Institute of Technology, Department of Aeronautics and Astronautics Visiting Committee
1994-Present	Member of the Draper Corporation
1994-1995	Member, National Research Council Committee on the Future of the Global Positioning System
2004-2005	Institute of Navigation President
1993-present	Associate Editor, Navigation
2006-2007	University of Colorado Emerging Leaders Program Fellow
2005-Present	University of Colorado Faculty Teaching Excellence Faculty Associate

### **Journal Publications (Selected, Total of 48)**

Names of Dr. Axelrad's students are underlined.

1. Parkinson, B.W. and P. Axelrad, "Autonomous GPS Integrity Monitoring Using the Pseudorange Residual," *NAVIGATION*, Vol. 35, No. 2, p. 255-274, 1988.
2. Axelrad, P., C.J. Comp, and P.F. MacDoran, "SNR Based Multipath Error Correction for GPS Differential Phase," *IEEE Transactions on Aerospace & Electronic Systems*, Vol. 32, No. 2, p. 650-660, April 1996.
3. Axelrad, P. and L.M. Ward, "Spacecraft Attitude Estimation Using the Global Positioning System: Methodology and Results for RADCAL," *Journal of Guidance, Control and Dynamics*, Vol. 19, No. 6, p. 1201-1209, November-December 1996.
4. Axelrad, P., and C.P. Behre, "Satellite Attitude Determination Based on GPS Signal-to-Noise Ratio," (Invited Paper) *Proceedings of the IEEE*, Vol. 87, No. 1, p. 133-144, January 1999.
5. Komjathy, A., V.U. Zavorotny, P. Axelrad, G.H. Born, and J.L. Garrison, "GPS Signal Scattering from Sea Surface: Wind Speed Retrieval Using Experimental Data and Theoretical Model," *Journal of Remote Sensing of Environment*, Vol. 73, p. 162-174, August 2000.
6. Moreau, M., P. Axelrad, J.L. Garrison, and A. Long, "GPS Receiver Architecture and Expected Performance for Autonomous Navigation in High Earth Orbits," *NAVIGATION*, Vol. 47, No. 3, p. 191-204, 2000.
7. Goldstein, D., G. Born and P. Axelrad "Real-time, Autonomous, Precise Orbit Determination Using GPS," *NAVIGATION*, Vol. 48, No. 3, p. 155-168, 2001.
8. Masters, D., P. Axelrad, and S. Katzberg, "Initial Results of Land-Reflected GPS Bistatic Radar Soil Moisture Measurements in SMEX02," *Remote Sensing of Environment*, Vol. 92:4 p. 507-520, 2004.
9. Lane, C. and P. Axelrad, "Analysis of Relative Navigation in High Earth Orbits," *Journal of the Astronautical Sciences*, Vol. 55, No 1, Jan-Mar 2007, p. 23-52.
10. Weiss, Jan P., P. Axelrad, S. Anderson, "A GNSS Code Multipath Model for Semi-Urban, Aircraft, and Ship Environments," *NAVIGATION*, Vol. 54, No.4, p. 294-307, 2007.
11. Tombasco, J., P. Axelrad, M. Jah, "Analysis of Specialized Coordinate Representation for Dynamic Modeling and Orbit Estimation in the Geosynchronous Regime," *Journal of Guidance, Control, and Dynamics*, Vol. 33, No. 6, p. 1824-1836, 2010.
12. Axelrad, P., B.K. Bradley, J. Donna, M. Mitchell, S. Mohiuddin, "Collective Detection and Direct Positioning Using Multiple GNSS Satellites," *NAVIGATION*, Vol. 58, No. 4, p. 305-321, 2011.
13. Bradley, B.K., B.A. Jones, G. Beylkin, K. Sandberg, P. Axelrad, "Bandlimited Implicit Runge-Kutta Integration for Astrodynamics," *Celestial Mechanics and Dynamical Astronomy*, 119:143-168, DOI: 10.1007/s10569-014-9551-x, 2014.



PER ENGE, PHD, NAE  
VANCE AND ARLENE COFFMAN  
PROFESSOR OF ENGINEERING  
DIRECTOR OF THE CENTER FOR  
POSITION NAVIGATION AND TIME

August 21, 2014

Professor Noel T. Clemens, Department Chair  
Care of: Laurie Gonzales, Department Manager  
Aerospace Engineering and Engineering Mechanics  
Cockrell School of Engineering  
The University of Texas at Austin

Re: Reference letter for Professor Todd Humphreys

Dear Committee Members,

I am happy to write this reference letter for Professor Todd Humphreys. We both work in the area of safety and security for navigation systems. I have known him for several years, mostly through the professional activities of the U.S. Institute of Navigation (ION). In addition, he invited me to give a talk at the Texas Wireless Summit in October of 2013, and I spent several hours with his research group on that visit to Austin. In addition, I invited him to give a talk at the Stanford Symposium on Position Navigation and Time in November of 2013.

The remainder of this letter is organized around your questions 2 through 4. I will focus on his more recent work on navigation security rather than his earlier work on ionospheric effects on satellite navigation, because I am much more familiar with the former.

**2. What are the original, innovative, and/or important contributions that he has made in his field of research? Have his publications influenced the thinking of, or the methods used by, others in your field?**

Dr. Humphreys has made worthy contributions to the field of navigation security. Workers in this field strive to mitigate the impact of jammers and spoofers on the Global Positioning System (GPS) and similar systems being developed around the world (e.g. Beidou in China, GLONASS in Russia and Galileo on Europe). These Global Navigation Satellite Systems (GNSS) are all vulnerable to electromagnetic attack, because all of the GNSS signals originate in medium earth orbit (MEO). The received signal powers are approximately  $10^{-16}$  Watts, and therefore terrestrial attackers can readily overwhelm (jam) or counterfeit (spoof) the satellite signals. Jammers act to deny the GNSS service, and spoofers act to distort the victim's estimate of position without the victim's knowledge. We say that jammers break GNSS continuity and spoofers attack GNSS integrity. Civilian concern for these issues has increased dramatically in the last few years, because GNSS has become more widely used to protect safety-of-life and financial transactions.

Dr. Humphreys has focused on the development of civil spoofing attacks and defenses. Specifically, he has demonstrated such attacks, developed threat models and designed mitigation strategies.

**Demonstration:** In widely publicized events, his UT team demonstrated the navigation capture of an unpiloted helicopter in Longhorn Stadium and White Sands Proving Grounds and a super yacht in the Mediterranean Sea. The UT attack was able to guide the helicopter and yacht based on modified GNSS signals coming from the ground. These demonstrations appropriately amplified civil concern about spoofing attacks on navigation receivers.

**Attack Models:** To mature the threat definition, Dr. Humphreys and his team have also developed much more detailed attack scenarios than any previous models in the civil community. These include the worrisome security code estimation and replay (SCER) attack, where the spoofers estimates any authentication symbols sent by the GNSS satellites and replays them with malevolent delays. He has also served the community by developing the Texas battery (TexBat) of spoofing attacks and making them available to his colleagues. These files contain the samples of a GNSS signal under attack by a spoofers; and may form the basis for standardized receiver tests in the future.

**Mitigation:** Dr. Humphreys has also made important contributions to the detection of spoofing attacks. He correctly envisages a picket fence of signal improvements and detection algorithms that would work together to mitigate spoofing. These include navigation message authentication (NMA) where cryptographic techniques are used to sign or authenticate the digital messages broadcast by the GNSS satellites. Dr. Humphreys and his team have proposed a powerful NMA system to be used with GPS. By themselves, cryptographic signatures do not protect the GNSS users against the SCER attacks mentioned above, because the spoofers can estimate the bits in the signature and replay them after a malevolent delay has been inserted. However, Dr. Humphreys has shown that a strong detection algorithm in the victim receivers can detect the error rate introduced by the spoofers. This algorithm would prevent the spoofers from introducing the short delays that are most difficult for the victim receivers to detect by other means.

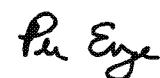
**3. How would you assess Dr. Humphreys' development compared with others in his cohort at research-intensive universities?**

At Stanford, we presently have five Assistant Professors on the tenure track in the Department of Aeronautics and Astronautics. Dr. Humphreys compares well to this group.

**4. What is your perspective on Dr. Humphreys' promise for further professional growth and leadership?**

Dr. Humphreys has a bright future. The field of navigation security has just opened in the civilian community and will be a strong research area for the next ten to fifteen years. Dr. Humphreys will certainly be a leader in this vital and interesting effort. More importantly, his technical work shows deep underlying knowledge of signal processing, detection and estimation theory, and experimental work. I have also spent several hours with his research group. They are a well-motivated, hard-working and accomplished team. These technical and leadership skills will sustain Dr. Humphreys long after the important problems in navigation security have been solved.

Respectfully,



Per Enge

**Gonzales, Laurie**

---

**From:** Per Enge <penge@stanford.edu>  
**Sent:** Thursday, August 21, 2014 9:57 PM  
**To:** Gonzales, Laurie  
**Subject:** Re: Todd Humphreys - External Review Request  
**Attachments:** Todd Humphreys Reference August 2014.pdf; ATT00001.htm

Hi Laurie,

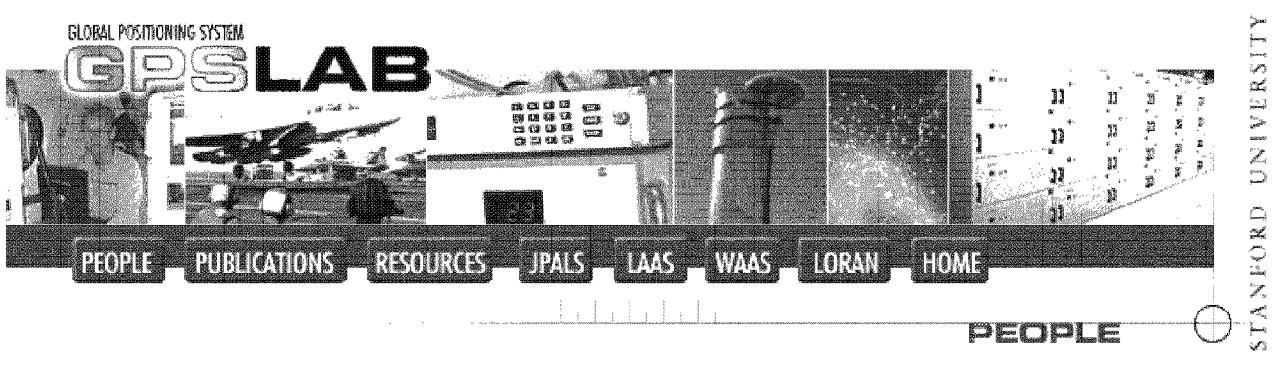
Here is the same letter with better formatting.

Cheers,  
Per

Stanford GPS Lab

<http://waas.stanford.edu/people/enge.htm>

Bio provided by ASE/EM.

**Per K. Enge, Ph.D., NAE**

Professor

Dept. of Aeronautics & Astronautics  
 Stanford University  
 Durand Building, Room 250  
 Stanford CA 94305-4035  
 Wk: (650) 723 2853  
 Fax: (650) 725 5517  
[per.enge@stanford.edu](mailto:per.enge@stanford.edu)

[C.V.]

Per Enge is a Professor of Aeronautics and Astronautics at Stanford University, where he is the Kleiner-Perkins, Mayfield, Sequoia Capital Professor in the School of Engineering. He directs the GPS Research Laboratory, which develops satellite navigation systems based on the Global Positioning System (GPS). These navigation systems augment GPS to improve accuracy and provide real time error bounds. In addition, the laboratory is developing a suite of technologies to mitigate the navigator's vulnerability to radio frequency interference. The laboratory has pioneered two such systems that are now operational. The first system uses a network of medium frequency radiobeacons to broadcast differential GPS corrections to maritime and land users. This system was developed for the U.S. Coast Guard, and today it covers much of the world's coastline and an increasing inland area. It provides differential GPS data to approximately 1.5 million users. The second is the Wide Area Augmentation System (WAAS) that was developed for the FAA. WAAS already serves millions of users, and became operational for aircraft in 2003. The laboratory is currently working on auto-land systems based on GPS. Foremost amongst these is the Local Area Augmentation System (LAAS) which supports larger airplanes at high-traffic hub airports. Per has received the Kepler, Thurlow and Burka Awards from the Institute of Navigation (ION) for his work. He is also a Member of the National Academy of Engineering as well as a Fellow of both the ION and the Institute of Electrical and Electronics Engineers (IEEE). He received his PhD from the University of Illinois in 1983, where he designed a direct-sequence multiple-access communication system that provided an orthogonal signal set to each user.

Per Enge and Pratap Misra have written the textbook "Global Positioning System: Signals, Measurements and Performance" which is designed to provide a comprehensive introduction to GPS. Per Enge is an advisor to several technology companies including Atheros and EveryTrail.

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## UNIVERSITY OF CALIFORNIA, RIVERSIDE

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SANTA BARBARA • SANTA CRUZ

MARLAN AND ROSEMARY BOURNS  
 COLLEGE OF ENGINEERING  
 DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

RIVERSIDE, CALIFORNIA 92521  
 OFFICE (951) 827-2484  
 FAX (951) 827-2425  
<http://www.ee.ucr.edu>

July 15, 2014

RE: Evaluation of Prof. Todd Humphreys

Dear Prof. Clemens:

This letter evaluates the scholarly contributions of Dr. Humphreys' for advancement to the rank of Associate Professor. I have never met Dr. Humphreys. I am only aware of him through his scholarly work. We have never collaborated either on papers or on projects.

Regarding the standard CV analysis, the candidate has 17 journal articles published or in press. Of the venues that I am familiar with IEEE T. on Signal Processing (TSP); J. of Field Robotics; IEEE J. on Selected Topics in Signal Processing; IEEE T. on Intelligent Transportation Systems; J. Guidance, Control and Navigation; and IEEE T. on Aerospace and Electronic Systems are all top quality venues. In these venues, he has nine publications, of which four are without his advisor and one is sole authored. Also, two of the conference papers published with his students have been recognized with prizes. These various factors demonstrate that he has established research independence that is also of high quality.

Research recognition and funding are enhanced by apt real world demonstrations. Dr. Humphreys has deftly succeeded in this realm through his team's taking control of a helicopter (Spring 2012) and yacht (Summer 2013) by spoofing their GPS receivers. In addition to technical expertise and indepth knowledge, such demonstrations take considerable time and effort to transition theory to practice, but the payoff is evidenced by the subsequent press coverage, buzz among researchers at ION conferences, and enhanced national prominence (e.g., congressional testimony) for him, his research, and UTA. Prior to the helicopter demonstration I was unaware of Dr. Humphreys. Afterward, the buzz at the ION conference caused many well-seasoned researchers to search out and read his papers. His related research on this topic has recently been published in the J. of Field Robotics, which is a very well respected venue. The paper is thorough, showing a deep understanding of GNSS receivers and including discussion and analysis of different spoofing approaches. Such research, with its effective demonstration, is the type of achievement that is worth much more than the paper counts which appear in standard academic letters of reference. His research is being discussed by world leaders and is affecting national GNSS, autonomous air vehicle, and research policies.

As a side note, it is commendable that the candidate has advised two Ph.D. students to completion, one of whom has earned a faculty position, prior to being evaluated for promotion to Associate Professor.

Dr. Humphreys has moved well beyond his PhD work. The breadth (e.g., ionospheric, GNSS security and receivers, collaborative navigation) of his contributions is particularly impressive. The phase reconstruction work is illustrative of the quality of his work. The TSP article presents theoretical

analysis backed-up by simulation and real world implementation studies. The results in the paper have important application for transportation and pedestrian applications that require both high accuracy and low power. I commend the candidate for his research approach combining both theory and implementation. He has established an independent, well-funded, and well-publicized research program with important impact. In doing so, he appears to have been both strategic and opportunistic. I have no worries about his future professional growth and leadership. In fact, if his research continues to earn this level of coverage with Congress and the national popular media (e.g., Scientific America), then he will be building the profile of an NAE member.

I strongly support his advancement to Associate Professor at UT-Austin and would do the same at my home institution.

Best regards,



Jay A. Farrell, Professor and Chair  
Department of Electrical and Computer Engineering  
v: 951-827-2159  
f: 951-827-2425

**Biography:** Jay A. Farrell earned B.S. degrees in physics and electrical engineering from Iowa State University, and M.S. and Ph.D. degrees in electrical engineering from the University of Notre Dame. At Charles Stark Draper Lab (1989-1994), he received the Engineering Vice President's Best Technical Publication Award in 1990, and Recognition Awards for Outstanding Performance and Achievement in 1991 and 1993. He is a Professor and two time Chair of the Department of Electrical Engineering at the University of California, Riverside. He has served the IEEE Control Systems Society (CSS) as Finance Chair for three IEEE CDC's ('95, '01, and '03), on the Board of Governors for two terms ('03-'06, '12-'14), as Vice President Finance and Vice President of Technical Activities, as CSS General Vice Chair of IEEE CDC-ECC 2011, as General Chair of IEEE CDC 2012, and as President in 2014. He was named a GNSS Leader to Watch for 2009-2010 by GPS World Magazine in May 2009 and a winner of the Connected Vehicle Technology Challenge by the U.S. Department of Transportation's (DOT's) Research and Innovative Technology Administration in July 2011. He is a Fellow of the IEEE, a Fellow of AAAS, a Distinguished Member of IEEE CSS, and author of over 200 technical publications. He is author of the book "Aided Navigation: GPS with High Rate Sensors" (McGraw-Hill 2008). He is also co-author of the books "The Global Positioning System and Inertial Navigation" (McGraw-Hill, 1998) and "Adaptive Approximation Based Control: Unifying Neural, Fuzzy and Traditional Adaptive Approximation Approaches" (John Wiley 2006). For full CV, see: [www.ee.ucr.edu/~farrell](http://www.ee.ucr.edu/~farrell)

**Gonzales, Laurie**

---

**From:** Jay Farrell <farrell@ee.ucr.edu>  
**Sent:** Monday, July 14, 2014 8:29 PM  
**To:** Gonzales, Laurie  
**Subject:** RE: Todd Humphreys - External Review Request  
**Attachments:** HumphreysUCR\_letterhead.pdf

Laurie  
Please see the attached letter.  
Jay

---

Jay A. Farrell, Professor and Chair  
Department of Electrical and Computer Engineering  
University of California  
Riverside, CA 92521  
v: 951-827-2159  
f: 951-827-2425  
url: [www.ee.ucr.edu/~farrell](http://www.ee.ucr.edu/~farrell)

---

Calendar: My calendar is available at  
<https://exchange.engr.ucr.edu/owa/calendar/farrell@ee.ucr.edu/Calendar/calendar.html>.  
To be useful, view it at either the day or week resolution, not the month resolution to which Microsoft defaults.

---

**From:** Gonzales, Laurie [mailto:[laurie.gonzales@austin.utexas.edu](mailto:laurie.gonzales@austin.utexas.edu)]  
**Sent:** Friday, June 13, 2014 2:02 PM  
**To:** Jay Farrell  
**Subject:** Todd Humphreys - External Review Request

Greetings, Dr. Farrell:

Please find attached a letter from Dr. Noel Clemens, Chair of the Department of Aerospace Engineering and Engineering Mechanics at The University of Texas at Austin, requesting your assistance in serving as an external reviewer for promotion to associate professor and tenure for Dr. Todd Humphreys. The review report would be due by July 28, 2014. If you are able to help us with this review, could you please let me know via email by June 20<sup>th</sup>?

Thank you,  
Laurie

---

Laurie Gonzales  
Department Manager  
Aerospace Engineering and Engineering Mechanics  
Cockrell School of Engineering  
The University of Texas at Austin  
(512) 471-5145 Direct

#### **Jay A. Farrell Biography**

Jay A. Farrell earned B.S. degrees in physics and electrical engineering from Iowa State University, and M.S. and Ph.D. degrees in electrical engineering from the University of Notre Dame. At Charles Stark Draper Lab (1989-1994), he received the Engineering Vice President's Best Technical Publication Award in 1990, and Recognition Awards for Outstanding Performance and Achievement in 1991 and 1993. He is a Professor and two time Chair of the Department of Electrical Engineering at the University of California, Riverside. He has served the IEEE Control Systems Society (CSS) as Finance Chair for three IEEE CDC's ('95, '01, and '03), on the Board of Governors for two terms ('03-'06, '12-'14), as Vice President Finance and Vice President of Technical Activities, as CSS General Vice Chair of IEEE CDC-ECC 2011, as General Chair of IEEE CDC 2012, and as President in 2014. He was named a GNSS Leader to Watch for 2009-2010 by GPS World Magazine in May 2009 and a winner of the Connected Vehicle Technology Challenge by the U.S. Department of Transportation's (DOT's) Research and Innovative Technology Administration in July 2011. He is a Fellow of the IEEE, a Fellow of AAAS, a Distinguished Member of IEEE CSS, and author of over 200 technical publications. He is author of the book "Aided Navigation: GPS with High Rate Sensors" (McGraw-Hill 2008). He is also co-author of the books "The Global Positioning System and Inertial Navigation" (McGraw-Hill, 1998) and "Adaptive Approximation Based Control: Unifying Neural, Fuzzy and Traditional Adaptive Approximation Approaches" (John Wiley 2006). For full CV, see: [www.ee.ucr.edu/~farrell](http://www.ee.ucr.edu/~farrell)

UNIVERSITY OF ILLINOIS  
AT URBANA-CHAMPAIGN

Department of Electrical and Computer Engineering

Remote Sensing and Space Sciences  
1308 West Main Street  
Urbana, IL 61801-2307



Professor Noel T. Clemens  
Department Chair and Bob R. Dorsey Professor in Engineering  
Department of Aerospace Engineering & Engineering Mechanics  
The University of Texas at Austin

August 4, 2014

Dear Professor Clemens:

I am pleased to provide my evaluation of Professor Todd Humphreys' scholarly contributions in response to your request for external assessment in considering him for promotion to the position of Associate Professor with tenure. I am a Professor of Electrical and Computer Engineering and a Professor of Statistics at the University of Illinois at Urbana-Champaign (UIUC). I am also a Research Professor at UIUC's Coordinated Science Laboratory, where I lead a research program in Remote Sensing and Space Science with particular emphasis on computational sensing and imaging of the solar-terrestrial environment.

Although I have known Professor Humphreys in person for slightly more than a year, I have been aware of his research work and contributions for the past several years. My familiarity with his contributions, despite the fact that I am not directly in his professional community, namely the satellite navigation community, is an important indication of the broad reach of his research contributions. In fact, his widespread recognition as the authority in the area of GPS (and more broadly GNSS) security and authentication was the reason that I approached him last year when I invited him to join a multi-university team that I put together for the formation of a proposal for a National Science Foundation Engineering Research Center (ERC). In the process of preparing the proposal, which was focused on GNSS-enabled technologies of the next decade, it became apparent that Professor Humphreys' expertise in positioning, navigation, and timing (PNT) solutions reach far beyond only the security and authentication aspects and cover diverse areas such as robust and energy-efficient next-generation GNSS receiver design and engineering, PNT coverage and integrity, and privacy. Professor Humphreys' breadth and depth in these areas impressed many of my senior collaborators and colleagues, which included several members of the National Academies.

Professor Humphreys is a widely recognized scholar with an impressive breadth of expertise and research contributions spanning the discovery and illustration of the vulnerability of GPS signals to spoofing, development of strategies for the detection of spoofing, development of techniques for the authentication of civil GPS signals, development and rigorous analysis of collaborative opportunistic navigation techniques, novel signal processing strategies for low-power GPS receiver technology, and modeling the effects of ionospheric scintillation on GPS carrier phase

Phone: (217) 333-4406 • Fax: (217) 333-4303 • e-mail: farzadk@uiuc.edu  
url: <http://www.ece.illinois.edu/directory/profile.asp?farzadk>

**UNIVERSITY OF ILLINOIS**  
**AT URBANA-CHAMPAIGN**

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tracking. His contributions in all of these diverse areas have been at the forefront of a number of activities being pursued within the PNT community and have had a profound impact on the advancement of state-of-the-art techniques.

A highly visible and influential work by Professor Humphreys for which he has received wide recognition, as evident by his activities in congressional testimonies, is in the area of drone security and privacy. While military GPS signals have long been encrypted to prevent counterfeiting and unauthorized use, in contrast, civil GPS signals and other open GNSS signals are unencrypted, unauthenticated, and openly specified in publicly available documents. These open signals are enormously popular because of their transparency and predictability, and are used in our critical infrastructure, including transportation, finance, and energy distribution. However, their transparency also gives rise to a dangerous weakness; the civil signals have been counterfeited or spoofed in dramatic recent demonstrations. In a series of papers, including “Unmanned Aircraft Capture and Control Via GPS Spoofing”, *Journal of Field Robotics*, 2014, Professor Humphreys illustrated the theory and practice of unmanned aerial vehicle (UAV) capture and control via GPS signal spoofing. In “Detection Strategy for Cryptographic GNSS Anti-Spoofing”, *IEEE Transactions on Aerospace and Electronic Systems*, 2013, he presented a strategy for detecting spoofing attacks against cryptographically secured GNSS signals, applicable both to military GPS signals and to security-enhanced civil GNSS signals. In “Practical Cryptographic Civil GPS Signal Authentication”, *Navigation: Journal of The Institute of Navigation*, 2012, he proposed an original and practical technique to authenticate civil GPS signals by combining cryptographic authentication of the GPS navigation message with signal timing authentication based on statistical hypothesis tests.

In the areas of PNT coverage and integrity, in a series of papers including “Observability Analysis of Collaborative Opportunistic Navigation With Pseudorange Measurements”, *IEEE Transactions on Intelligent Transportation Systems*, 2014, Professor Humphreys developed strategies for exploiting signal diversity to improve navigation and timing robustness compared with stand-alone GPS receivers in deep urban, indoor, or, otherwise, GPS-hostile environments. In “A Phase-Reconstruction Technique for Low-Power Centimeter-Accurate Mobile Positioning”, *IEEE Transactions on Signal Processing*, 2014, he developed an innovative carrier phase reconstruction technique, based on solving a mixed real and integer estimation problem to reconstruct a continuous carrier phase time history from intermittent phase measurement intervals each having an ambiguous initial phase, to enable low-power centimeter-accurate mobile positioning. Such innovations, pioneered by Professor Humphreys, will be instrumental in pervasive, seamless civilian applications of GNSS, toward ubiquitous sensing of our society and habitat in areas such as traffic management, precision agriculture, emergency response, commercial aviation, autonomous vehicles, marine navigation, environmental sensing, critical

*Phone:* (217) 333-4406 • *Fax:* (217) 333-4303 • *e-mail:* farzadk@uiuc.edu  
*url:* <http://www.ece.illinois.edu/directory/profile.asp?farzadk>

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Department of Electrical and Computer Engineering

Remote Sensing and Space Sciences  
1308 West Main Street  
Urbana, IL 61801-2307



resource and infrastructure monitoring, banking, and mobile phone operations. Professor Humphreys is strategically positioned to lead innovation and discovery in these exciting areas.

As evident from his *curriculum vitae*, Professor Humphreys has demonstrated his ability to establish a thriving research group at UT Austin, supported through sponsorship by federal funding agencies as well as industry. He has been very effective at graduate student advising and mentoring, as evident by awards they have received while under his supervision. Also, from his CV it is clear that he has been effective, with distinction, at classroom instruction.

In summary, on the basis of the analysis I have provided above, I enthusiastically endorse Professor Humphreys' advancement to the rank of Associate Professor with tenure at UT Austin.

Farzad Kamalabadi

*Farzad Kamalabadi*

Professor, Department of Electrical and Computer Engineering

Professor, Department of Statistics

Phone: (217) 333-4406 • Fax: (217) 333-4303 • e-mail: farzadk@uiuc.edu  
url: <http://www.ece.illinois.edu/directory/profile.asp?farzadk>

**Gonzales, Laurie**

---

**From:** Kamalabadi, Farzad <farzadk@illinois.edu>  
**Sent:** Wednesday, August 06, 2014 12:58 AM  
**To:** Gonzales, Laurie  
**Subject:** RE: Reminder: Promotion and Tenure Review for Todd Humphreys  
**Attachments:** Reference-TH-UTA.pdf; Kamalabadi-bio-UTA.pdf

Dear Laurie,

Attached please find the letter for Dr. Humphreys and my short bio.

Best wishes,

-Farzad

---

**From:** Gonzales, Laurie [laurie.gonzales@austin.utexas.edu]  
**Sent:** Monday, August 04, 2014 2:21 PM  
**To:** Kamalabadi, Farzad  
**Subject:** Re: Reminder: Promotion and Tenure Review for Todd Humphreys

Any time tomorrow would be fine. Thanks.

> On Aug 4, 2014, at 2:00 PM, "Kamalabadi, Farzad" <[farzadk@illinois.edu](mailto:farzadk@illinois.edu)> wrote:  
>  
> Hi Laurie,  
>  
> Sorry again to let this drag on, but would the end of the day tomorrow still be ok? If you need it for a meeting during the day tomorrow, I'll get it completed tonight.  
>  
> Thanks,  
>  
> -Farzad  
>  
>  
> \_\_\_\_\_  
> From: Gonzales, Laurie [laurie.gonzales@austin.utexas.edu]  
> Sent: Tuesday, July 29, 2014 8:48 AM  
> To: Kamalabadi, Farzad  
> Subject: RE: Reminder: Promotion and Tenure Review for Todd Humphreys  
>  
> The end of this week or even Monday would be fine.  
>  
> Thanks,  
> Laurie  
>  
> -----Original Message-----  
> From: Kamalabadi, Farzad [<mailto:farzadk@illinois.edu>]

> Sent: Tuesday, July 29, 2014 8:31 AM  
> To: Gonzales, Laurie  
> Subject: RE: Reminder: Promotion and Tenure Review for Todd Humphreys  
>  
> Dear Laurie,  
>  
> I am almost done with the review letter. Would it be alright if I get it to you by the end of this week? If there is an urgency due to internal deadlines, please let me know and I will expedite it.  
>  
> Best wishes,  
>  
> -Farzad  
>  
>  
> \_\_\_\_\_  
> From: Gonzales, Laurie [laurie.gonzales@austin.utexas.edu]  
> Sent: Monday, July 14, 2014 9:19 AM  
> Subject: Reminder: Promotion and Tenure Review for Todd Humphreys  
>  
> Good morning:  
>  
> Thank you again for agreeing to write an external review for Dr. Todd Humphreys. Submission of your review and a brief bio or abbreviated CV by July 28th would be greatly appreciated. If there's anything additional you need to complete the review, please don't hesitate to contact me.  
>  
> Cheers,  
> Laurie  
> -----  
> Laurie Gonzales  
> Department Manager  
> Aerospace Engineering and Engineering Mechanics Cockrell School of Engineering The University of Texas at Austin  
> (512) 471-5145 Direct  
> (512) 471-7593 Main  
>

Farzad Kamalabadi is Professor of Electrical and Computer Engineering (Full, 2011-present; Associate, 2006-2011; Assistant 2000-2006) and Professor of Statistics at the University of Illinois at Urbana-Champaign (UIUC), where he has been on the faculty since 2000. He is also a Research Professor at UIUC's Coordinated Science Laboratory, where he leads a research program in space science and remote sensing with particular emphasis on computational sensing and imaging of the solar-terrestrial environment. From 2010 to 2012, he was also a Program Director at the National Science Foundation (NSF) Division of Atmospheric and Geospace Sciences. He was a Visiting Fellow with SRI International in 2002, a NASA Faculty Fellow with the Jet Propulsion Laboratory, California Institute of Technology in 2003, and a Visiting Professor with the French National Research Institute for Computer Science and Control (Institut National de Recherche en Informatique et en Automatique), Sophia Antipolis, France in 2008-2009.

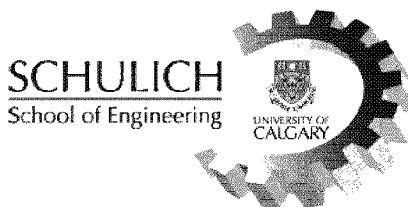
Dr. Kamalabadi's scientific and technical contributions span solar-terrestrial remote sensing and imaging, ionospheric and space physics, development of optical and radio sensing and imaging techniques, multidimensional and statistical signal processing, and data assimilation. His research contributions have resulted in more than 90 refereed publications. For his scholarly contributions, he has received a UIUC College of Engineering Xerox Award for Outstanding Faculty Research in 2006, UIUC List of Teachers Ranked as Excellent by Their Students in 2006, 2007, and 2013, Engineering Council Award for Excellence in Advising in 2004, a NSF Faculty Early Career Development (CAREER) Award in 2002, and a NASA Graduate Student Researchers Program (GSRP) Fellowship in 1998. In 2010, he was selected to National Academies Keck Futures Initiative on Imaging Science and was a keynote speaker at the Astronomical Data Analysis Conference.

Dr. Kamalabadi is a Co-Investigator on NASA's Ionospheric Connection Explorer (ICON) mission and science lead on its Far Ultraviolet Imager (FUV) instrument. He has served on the science definition team, and as guest investigator, of numerous space missions. He has served in editorial, reviewing, and organizing capacities for numerous scientific and technical publications and workshops. He currently serves as Associate Editor for IEEE Signal Processing Letters.

In his capacity as Program Director in the Geospace Section at NSF, Dr. Kamalabadi had the administrative and management responsibility of overseeing more than \$30 million in research grants. He has played leadership roles in program development and science policy, including the inception, definition, and execution of a major program, "Frontiers in Earth System Dynamics", for which he received the NSF Director's Award for Collaborative Integration. Dr. Kamalabadi represented NSF at numerous interactions with national and international agencies and academic institutions, including the National Academies, National Research Council, NASA, as well as at meetings with international governments and scientific organizations. He coauthored the request to the Space Studies Board of the National Research Council (NRC) to produce "A Decadal Strategy for Solar and Space Physics", and an NRC report on "The Effects of Solar Variability on Earth's Climate". He was involved in the NSF review of National Center for Atmospheric Research (NCAR) and, in collaboration with NASA partners, developed a joint NSF-NASA strategic capability program in space weather modeling.

Dr. Kamalabadi has played leadership roles on numerous national and international advisory and steering committees including NASA Living With a Star Targeted Research & Technology Steering Committee (2010-present), Space Weather Enterprise Forum Steering Committee (2010), Arecibo Observatory's Users and Scientific Advisory Committee (2007-2009), NSF Committee of Visitors (2005), NSF CEDAR Science Steering Committee (2003-2005; 2012-present), and Advisory Board of the European Commission Solar Irradiance Data Exploitation Project (2013-present).

He received a B.S. degree in computer systems engineering from the University of Massachusetts, Amherst (1991), and M.S. and Ph.D. degrees in electrical engineering from Boston University (1994 and 2000, respectively). More detailed information including his significant publications can be found at: <http://www.ece.illinois.edu/directory/profile.asp?farzadk>



PLAN Group

**Department of GEOMATICS ENGINEERING**

Professor Gérard Lachapelle, PEng, FRSC, FCAE, FRIN, FION  
Canada Research Chair in Wireless Location

Telephone: (403) 220-7104

E-mail: [Gerard.Lachapelle@ucalgary.ca](mailto:Gerard.Lachapelle@ucalgary.ca)

Website: <http://plan.geomatics.ucalgary.ca>

10 July 2014

Professor Noel T. Clemens  
Department Chair and Bob R. Dorsey Professor in Engineering  
Aerospace Engineering & Engineering Mechanics  
The University of Texas at Austin  
Austin, Texas 78712-1221  
USA

Dear Professor Clemens

**Re: Evaluation of Professor Todd Humphreys (Tenure and Promotion to Associate Professor)**

I provide this evaluation as per your request of June 13. I have no personal or business affiliation with Professor Humphreys that can be construed as a conflict of interest. I have met him on several occasions at conferences related to GNSS during the past eight to 10 years and followed closely some of his research. My own area of expertise, which is fully described on the website listed in the header of this letter, is GNSS navigation. Having been Head of our Department of Geomatics Engineering for eight years (1995-03), I have been involved on a regular basis on academic evaluation and promotion committees in our Schulich School of Engineering.

Professor Humphreys' early research contributions during and after his doctoral studies were on the effect of the ionosphere on GNSS. He was part of a strong group in this area at Cornell University and these contributions were well received. He has continued to conduct very good quality research in this area. Starting in the late 2000s, his major focus has been on the development of anti-spoofing methods for GNSS. He was among the very first experts to describe the threat of spoofing of GPS to the GPS civilian community. This has resulted in a rapidly increasing level of research and development activities in the area of counter-measures (anti-spoofing methods) by scores of civilian academic and industrial organizations since. His own novel research contributions in this area have garnered much attention and, as a consequence, he has become one of the few eminent researchers in the world in this area. Professor Humphreys is an excellent communicator and his papers are of a high quality and appreciated by researchers. His online TED lecture on "How to Fool a GPS" is highly successful and instrumental in promoting awareness of spoofing threats to GPS. He has been called to participate on numerous high level working groups as an expert in this area. These demonstrate an exceptional leadership capability, the more at the stage of his career.

The above accomplishments have occurred over a short period of 5 years. His development compared with others at research-intensive universities places him positively in the top 5% of his cohort. I firmly believe that his potential for further professional growth is exceptional. He already established himself as a leader in the area of GNSS.

In conclusion, I find Professor Humphreys' research and professional records outstanding. I believe without a doubt that his record at the level of assistant professor would result in promotion to the level of associate professor in most engineering faculties.

Regards

A handwritten signature in black ink, appearing to read "Gérard Lachapelle". The signature is fluid and cursive, with a prominent 'G' at the beginning.

G. Lachapelle

**Gonzales, Laurie**

---

**From:** Gerard Lachapelle <lchapelle@ucalgary.ca>  
**Sent:** Thursday, July 10, 2014 5:45 PM  
**To:** Gonzales, Laurie  
**Subject:** Re: Todd Humphreys - External Review Request  
**Attachments:** Evaluation of Todd Humphreys-July2014.pdf

Laurie - My evaluation letter is attached. Could you please confirm?

Regards - Gérard L

Professor Gérard Lachapelle  
Canada Research Chair in Wireless Location  
Geomatics Engineering  
Schulich School of Engineering  
University of Calgary  
2500 University Drive NW  
Calgary T2N 1N4, AB, CANADA  
Website: <http://plan.geomatics.ucalgary.ca>  
e-mail: [Gerard.Lachapelle@ucalgary.ca](mailto:Gerard.Lachapelle@ucalgary.ca)

On 2014-06-13, at 3:08 PM, Gonzales, Laurie wrote:

Greetings, Dr. Lachapelle:

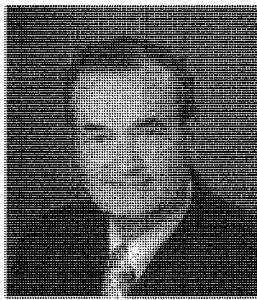
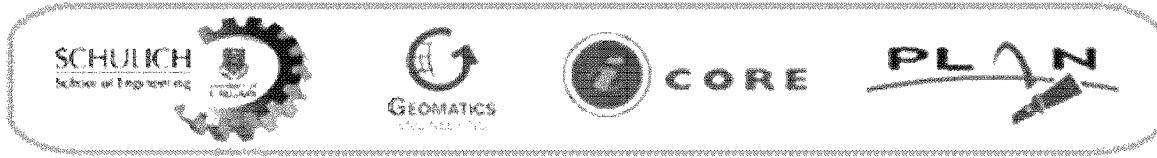
Please find attached a letter from Dr. Noel Clemens, Chair of the Department of Aerospace Engineering and Engineering Mechanics at The University of Texas at Austin, requesting your assistance in serving as an external reviewer for promotion to associate professor and tenure for Dr. Todd Humphreys. The review report would be due by July 28, 2014. If you are able to help us with this review, could you please let me know via email by June 20<sup>th</sup>?

Thank you,  
Laurie

---

*Laurie Gonzales  
Department Manager  
Aerospace Engineering and Engineering Mechanics  
Cockrell School of Engineering  
The University of Texas at Austin  
(512) 471-5145 Direct  
(512) 471-7593 Main*

<Humphreys CV 6-4-2014.pdf><detection\_strategy\_humphreys.pdf><observability\_analysis\_kassas.pdf><phase\_reconstruction\_pesyna.pdf><practical\_cryptographic\_wesson.pdf><unmanned\_capture\_kerns.pdf><Humphreys P&T-Lachapelle.pdf>



## *Resume* *Professor Gérard Lachapelle*

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**POSITION:** Professor, Dept of Geomatics Engineering, University of Calgary, and Canada Research Chair in Wireless Location.

### **OVERVIEW**

Professor Gérard Lachapelle leads the Position, Location And Navigation (PLAN) Group in the Department of Geomatics Engineering, University of Calgary (<http://PLAN.geomatics.ucalgary.ca>). His research focuses on navigation and wireless location using GNSS, ground-based RF techniques, integrated systems and indoor GNSS. His research team currently focuses on the development of advanced GNSS signal processing methods, multi-frequency GNSS software receivers and ultra-tight GNSS-INS methods and software receivers. He has been involved with the development and testing of advanced GPS-based methods and algorithms since 1980. During the past ten years, he has also contributed to the development of mobile telephone location techniques and indoor location. The software and patents he has developed with his colleagues since joining the University of Calgary in 1988 have generated \$5M in revenue. He has also made numerous contributions to geodesy and hydrography earlier on in his career. His work is recognized worldwide and he has received scores of awards for his contributions. He has served the profession extensively through service in numerous scientific, technical and professional societies. Thousands of engineers and other experts worldwide have taken his GPS and other professional courses during the past 25 years. He has contributed to the training of hundreds of BSc students and has supervised 90 post-graduate students to completion till now. Details of his past and current research activities at the University of Calgary can be found on the above website.

### **ACADEMIC AND PROFESSIONAL QUALIFICATIONS**

- Dr.techn. (Science), Technical University at Graz, Austria, 1975
- L.Ph. (Science), University of Helsinki, Finland, 1973
- M.Sc. (Science), University of Oxford, United Kingdom, 1972
- B.Sc. (Applied Sciences - Surveying), Université Laval, Québec, Canada, 1971
- P.Eng. (Professional Engineer) - Alberta, since 1983

### **MEMBERSHIP IN PROFESSIONAL ASSOCIATIONS AND LEARNED SOCIETIES**

- Institute of Navigation (Western Vice-President, 2002-03, Alberta Section Chair ,1999-2009)
- Royal Institute of Navigation (U.K.)
- Association of Professional Engineers, Geologists, and Geophysicists of Alberta (APEGGA)
- Canadian Institute of Geomatics (President, 1983-84)
- Institute of Electrical & Electronics Engineers, Inc

July 2011

## WORK EXPERIENCE

Professor, Department of Geomatics Engineering, University of Calgary (1988 - present). Canada Research Chair in Wireless Location (2001-15), Informatics Centre of Research Excellence Chair on Wireless Location (2001-2010). Head, Department of Geomatics Engineering, University of Calgary, 1995-2003. Executive Vice President, Norstar Instruments Ltd (1985-1988). Executive Vice President, Advanced Technologies, Nortech Surveys (Inc.) Canada (1983 - 1988). Head, Geodetic Research and Development, Sheltech Canada, a Division of Shell Canada Resources Ltd. (1980 - 1982). Research and Development Section (1975-1980), Geodetic Survey of Canada, Surveys & Mapping Branch, Department of Energy, Mines, and Resources, Ottawa.

## MAJOR DISTINCTIONS AND AWARDS (SINCE 1997)

- Over 35 best paper awards received by self and graduate students at international conferences related to navigation during the last 15 years
- Graduate Educator Award, Schulich School of Engineering, University of Calgary, 2010
- Weems Award, U.S. Institute of Navigation, 2009
- The Alberta Ingenuity Fund Research Excellence Award, APEGGA, 2007
- Fellow, Royal Institute of Navigation, U.K., 2006
- Michael Richey Medal (with Ross Stirling and Ken Fyfe for joint contribution), Royal Institute of Navigation, 2006
- Alberta Centennial Medal, 2005
- 2005 Schulich School of Engineering Graduate Education Award, University of Calgary
- 2005 Casey Baldwin Award, Canadian Aeronautics and Space Institute, together with colleagues from the University of Calgary and Spirent Communications (SW) Limited, U.K.
- 2004 Outstanding Leadership in Alberta Technology, Alberta Science and Technology (ASTech) Leadership Foundation
- 2004 Research Excellence Award, Faculty of Engineering, University of Calgary
- Honorary Professor, Universita' Degli Studi Di Napoli Parthenope, Naples, Italy, 2003
- Fellow, The Institute of Navigation, U.S.A., 2003
- Fellow, Canadian Academy of Engineering, 2003
- Honorary Professor, University of Wuhan, China, 2002
- Fellow, Royal Society of Canada, 2002
- APEGGA Frank Spragins Summit Award, for integrity, expertise and outstanding accomplishments in engineering, 2000
- Honorary Professor, University of Electronic Science and Technology of China, 1999
- Alouette Award, Canadian Aeronautics and Space Institute, 1998, for outstanding achievement in space science and engineering
- Johannes Kepler Award, U.S. Institute of Navigation, 1997, for sustained and significant achievements to the field of satellite-based navigation

## MAJOR SCIENTIFIC AND PROFESSIONAL SERVICE (SINCE 2000)

- Editor (Navigation), *IEEE Transactions on Aerospace and Electronic Systems*, 2003-09, and Associate Editor-in-Chief, 2006-09
- Western Vice-President, U.S. Institute of Navigation, 2002-2003
- Chair, Alberta Chapter, Institute of Navigation, 1999-2009
- Editorial Board, *GPS Solutions*, 1999-2009, and *GPS World*, 1989-present
- Technical and General Chair, GPS01 and GPS02, The Institute of Navigation

## PUBLICATIONS

Professor Lachapelle has been involved as author or co-author in over 400 papers and reports, including 200 in refereed journals and co-authorship in two books, including the first book on GPS in 1987.

## RESEARCH FUNDING

Professor Lachapelle has raised millions of dollars in research funding since joining the university in 1988. He currently raises over \$1M per year in research funds (iCORE, CRC, NSERC, NCE, industry and government contracts). The latter are mostly from Canadian and U.S. industry and government.

July 2011




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UNIVERSITY OF NEW BRUNSWICK	DEPARTMENT OF <b>GEODESY AND GEOMATICS ENGINEERING</b>	P.O. BOX 4400 FREDERICTON, NB CANADA E3B 5A3	TEL: 506-453-4698 FAX: 506-453-4943 COURIER: 15 DINEEN DRIVE, RM E54 <a href="mailto:gge@unb.ca">gge@unb.ca</a> <a href="http://gge.unb.ca">gge.unb.ca</a>
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21 August 2014

Prof. Noel T. Clemens  
 Dept. of Aerospace Engineering & Engineering Mechanics  
 The University of Texas at Austin  
 210 E. 24th Street – Stop C0600  
 Austin, TX 78712-1221  
 U.S.A.

Dear Prof. Clemens:

You have asked for my help in evaluating Dr. Todd Humphreys of your department in The University of Texas at Austin at the time of his assessment for tenure and advancement in rank to the position of associate professor. Specifically, you have asked for my opinion on his scholarly distinction; i.e., research performance. I am happy to provide a brief assessment. But first, let me introduce myself.

I am a tenured full professor in the Department of Geodesy and Geomatics Engineering at the University of New Brunswick (UNB) in Fredericton, New Brunswick, Canada, where I have been teaching and doing research since 1981. UNB is a mid-sized comprehensive university and Canada's oldest English-speaking university. It is well-known for its fully accredited Faculty of Engineering. Its Department of Geodesy and Geomatics Engineering is a UNB flagship department, with a research ranking of 1 – a position shared with only a few other departments in the university. I am the senior full-time researcher in the department's Geodetic Research Laboratory and head up the Global Navigation Satellite Systems (GNSS) Research Group, which consists of four faculty members and a dozen or so graduate students and post-doctoral fellows. My general area of expertise is precision applications of GNSS, of which the Global Positioning System is preeminent. Specific current projects include: overseeing the continued development of the UNB real-time kinematic (RTK) positioning software for machine guidance and other applications; development of techniques for ameliorating the effects of multipath in GNSS positioning and navigation; development of single- and dual-frequency GNSS point positioning software; using GPS as an ionospheric research tool and developing methods to minimize the effects of

the ionosphere and the neutral atmosphere on positioning and navigation; and analysis of data from the GPS Attitude, Positioning, and Profiling instrument of the e-POP platform on the Canadian CASSIOPE small satellite, launched in 2013 for which I am the principal investigator. See also <[http://www2.unb.ca/gge/Research/GRL/GNSS\\_Group\\_Projects.pdf](http://www2.unb.ca/gge/Research/GRL/GNSS_Group_Projects.pdf)>.

I was, of course, already aware of Dr. Humphreys and his work and have followed his career since he was a Ph.D. graduate student in aerospace engineering at Cornell University.

In evaluating Dr. Humphreys' suitability for promotion, let me use several discussion points that I have used in the past to assess candidates being considered for promotion and/or tenure.

### **Quality and Quantity of Candidate's Research Output**

Dr. Humphreys' research has covered a wide range of GPS-related topics. These include, among others, the study of ionospheric scintillation and its effects on GPS, the development of a dual-frequency software-defined GPS receiver-spoofing for navigation and timing security research, the study of GPS spoofing and countermeasures, and investigations in the area of estimation and signal processing. His research productivity is outstanding. In his c.v., he lists 41 conference publications that he authored or co-authored between 2002 and 2014. Many of these were presented at the preeminent Institute of Navigation (ION)/IEEE GPS/GNSS conferences and two of them received "best paper" awards.

The number of refereed journal publications published by Dr. Humphreys is above the norm for someone being considered for promotion to associate professor. Since 2009, when he began his employment at the University of Texas, he has published 18 papers (including those currently under review) or an average of more than three papers per year. Dr. Humphreys is the lead author on a number of them. The papers are all in leading journals such as the ION's journal, *Navigation; Radio Science*; various IEEE journals including *IEEE Transactions on Aerospace and Electronic Systems*; and the *Journal of Guidance, Control, and Dynamics*. These journals have high impact value. The sample papers that I received to help in my assessment are representative of the high calibre of Dr. Humphrey's work.

In his c.v., Dr. Humphreys has a long list of other major publications (including several in *GPS World* for which I am a contributing editor) and oral presentations. His oral presentations include a *TEDx Austin* talk, which has received quite a bit of attention. He has co-founded the Coherent Navigation company. He also shared in three patents.

Dr. Humphreys has attracted a very significant number of research grants and contracts with a value of over four million dollars! I won't repeat the details here as they are well documented in his c.v.

### **Training of Highly Qualified Personnel**

Dr. Humphreys currently supervises five graduate students. Two Ph.D. students and two M.S. students have received their degrees under his tutelage. This is a better than average accomplishment in just five years.

### **Journal Editorship**

Dr. Humphreys is the new editor of *IEEE Transactions on Wireless Communications*. Clearly Dr. Humphreys has achieved both national and international stature in his field to have been invited to edit the journal.

### **Awards**

Dr. Humphreys has received several awards for his research and teaching from within the University of Texas and from national organizations. They include the *University of Texas System Regents Outstanding Teaching Award* for 2012 and the *Cockrell School Dean's Award for Outstanding Teaching by an Assistant Professor* for 2012. I have already mentioned the ION/IEEE best paper awards. Dr. Humphreys also received a *GPS World Magazine Leadership Award* in 2012, one of only four awards handed out each year. This award is given to those making recent outstanding contributions in the world of global navigation satellite systems worldwide.

### **Appointments**

Dr. Humphreys has served on the ION Council. He was on the ION GNSS+ 2013 technical program committee and has been a session chair for a number of ION/IEEE conferences. He has given congressional testimony on drone security and has been an invited subject matter expert for several government agencies.

### **Level of Candidate's Performance Compared to Others in the Field**

Such a comparison should be done with candidates at the same career level; i.e., having held the rank of assistant professor for several years. I would rate Dr. Humphreys' performance as very high – perhaps even outstanding – compared to others in his peer group, both nationally and internationally.

**Would the Candidate be Likely to Receive Promotion If He Were at UNB?**

Yes, he certainly would, given his impressive research performance, especially considering that his teaching and service commitment would also be rated very highly.

**Overall Assessment and Recommendation**

I think that Dr. Humphreys has had and continues to have a level of performance in his research endeavours, which clearly merits promotion to associate professor with tenure. Nationally, he is one of the leader's in his field and has established a successful career, which will bring him further national and international distinction and which will help maintain the high calibre of the Dept. of Aerospace Engineering & Engineering Mechanics at The University of Texas at Austin.

Should you have any questions concerning my assessment or have specific directed questions on matters I did not cover, I would be very happy to answer them.

Yours sincerely



Richard B. Langley  
Professor of Geodesy and Precision Navigation  
Fellow of the International Association of Geodesy, The Institute of  
Navigation, and the Royal Institute of Navigation  
Geodetic Research Laboratory  
E-mail: lang@unb.ca

**Gonzales, Laurie**

---

**From:** Richard B. Langley <lang@unb.ca>  
**Sent:** Thursday, August 21, 2014 3:32 PM  
**To:** Gonzales, Laurie  
**Subject:** Re: Reminder: Promotion and Tenure Review for Todd Humphreys  
**Attachments:** RBL\_Letter\_to\_UT\_Austin\_re\_Humphreys.letterhead.pdf; ATT00001.txt

Here it is. Please let me know if you need anything further.

-- Richard

Bio provided by the ASE/EM; <http://www2.unb.ca/gge/Personnel/Langley/Langley.html>

## Richard B. Langley

Richard Langley is a professor in the Department of Geodesy and Geomatics Engineering at the University of New Brunswick (UNB), where he has been teaching and conducting research since 1981. He has a B.Sc. in applied physics from the University of Waterloo and a Ph.D. in experimental space science from York University, Toronto. After obtaining his Ph.D., Dr. Langley spent two years with the Department of Earth and Planetary Sciences of the Massachusetts Institute of Technology where he carried out research in geodetic applications of lunar laser ranging and very long baseline interferometry.

Dr. Langley has worked extensively with the Global Positioning System. He is a co-author of the best-selling Guide to GPS Positioning published by Canadian GPS Associates and is a columnist and contributing editor of GPS World magazine. He has helped develop and present a number of seminar courses on GPS over the years. Dr. Langley has consulted extensively in the field of GPS with private companies and government agencies both in Canada and abroad.

Dr. Langley holds appointments to several national and international bodies including the Canada-wide Differential GPS Service Management Board and the The Institute of Navigation.

For his contributions to space geodesy, Dr. Langley shared two awards from the U.S. National Aeronautics and Space Administration. In 2004, he was made a fellow of The Institute of Navigation and in 2007, he was made a fellow of the Royal Institute of Navigation. In 2007, Dr. Langley also received The Institute of Navigation's Johannes Kepler lifetime achievement award.

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## Professional Activities

- Chair, Canadian National Committee for International Union of Geodesy and Geophysics (IUGG) (92-97)
- International Association of Geodesy (IAG) Fellow and Coordinator for Education Initiatives (95-99)
- Member, Council of International Union of Surveys and Mapping (IUSM) (92-97)
- Corresponding Member, International Earth Rotation Service (IERS), Paris (90-01)
- UNB Representative for UNAVCO, the University NAVSTAR Consortium (87-02)
- Member, International Association of Geodesy (IAG) Special Study Group 1.158 (GPS Antenna and Site Effects) (95-99)
- Member, International Association of Geodesy (IAG) Special Study Group 1.159 (Use of GPS Positioning for Atmospheric Monitoring) (95-99)
- National Member, International Association of Geodesy (IAG) Commission VIII, International Coordination of Space Techniques for Geodesy and Geodynamics (CSTG) (99-03)

- Member, International Association of Geodesy ([IAG](#)) Ad Hoc Working Group on the Refractive Indices of Light, Infrared, and Radio Waves in the Atmosphere (99-03)
- Member, International Association of Geodesy [Inter-commission Study Group 1.2 \(Use of GNSS for Reference Frames\)](#) (03-07)
- Member, International Association of Geodesy [Sub-commission 4.5 \(Next Generation RTK\)](#) (03-07)
- Member, [IGS Galileo/GNSS Working Group](#) (03-04)
- Member, [IGS Low Earth Orbiters Working Group](#) (02-04)
- Associate, Committee on Space Research ([COSPAR](#))
- Correspondent, International Union of Radio Science ([URSI](#))
- Member, National Research Council of Canada Committee on International Science, Engineering and Technology (01-07)
- External examiner, [University of the West Indies Department of Surveying and Land Information](#) (99-03)
- Contributing Editor, [GPS World](#)
- Member, [Canada-wide DGPS Service Management Board](#)
- Investigator, [GEOIDE Network of Centres of Excellence](#)
  - [ENV#14: Improvement of Precise and Reliable Kinematic GPS Positioning in Real-time over Long Distances for the Support of Bathymetric Surveys \(Latest annual report\)](#) (99-02)
  - [ENV#17: Natural Hazards and Disaster Monitoring](#) (99-02)
  - [RES#47: Airborne Gravity for Exploration and Mapping \(AGEM\)](#) (99-01)
  - [SLM-ASR#27: Mapping the Ocean Surface with Geodetic and Oceanographic Tools](#) (05-08)
  - [TDM-ASR#31: Next-generation Algorithms for Navigation, Geodesy and Earth Sciences under Modernized Global Navigation Satellite Systems \(GNSS\)](#) (05-08)

Consultant to several Canadian and international private and government agencies. He was a partner in Canadian GPS Associates.



DEPARTMENT OF ELECTRICAL  
AND COMPUTER ENGINEERING

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(513)-529-0745 FAX

July 26, 2014

Professor Noel Clemens  
Professor and Chair  
Aerospace Engineering & Engineering Mechanics  
The University of Texas at Austin  
Austin, TX 78712

Dear Professor Clemens,

It is my great pleasure to write this reference letter to support Dr. Todd Humphreys' promotion to Associate Professor with tenure at your university. Let me first share with you my professional background. I am currently a Professor of Electrical Engineering at Miami University, Oxford, OH and will be a Professor in the Department of Electrical and Computer Engineering at Colorado State University in August, 2014. My major areas of research are in advanced global navigation satellite systems (GNSS) receiver algorithms for signals in both physically and electromagnetically challenging environments, GNSS remote sensing and studies of the Earth ionosphere processes and phenomena, multifunctional software-defined ultra-wide band SAR for navigation, imaging, and networking, and navigation sensor integrations and applications. Some of my areas of interest overlap those of Dr. Humphreys. I have served IEEE and the Institute of Navigation in various capacities and evaluated numerous promotion and tenure packages in the field of satellite navigation for institutions both inside the US and abroad. The attached resume details my technical and professional qualifications. In this letter, I will address each point specified in your request.

1. Do you know Dr. Humphreys, and if so, for how long and under what circumstances?

I became acquainted with Dr. Humphreys around 2008 while he was still at Cornell University. We met at the annual Global Navigation Satellite Conference (GNSS) sponsored by the Institute of Navigation (ION) where we were both giving presentations on topics of mutual interests. Since then, we had frequent encounters at various navigation and GNSS related conferences and workshops. In the past two years, we both served on ION Council and met regularly at Council meetings. We also maintained email communications and discussions related to technical issues and professional services.

2. What are the original, innovative, and/or important contributions that he has made in his field of research? Have his publications influenced the thinking of, or the methods used by, others in your field??

Dr. Humphreys has made several important contributions in the field of GNSS. His GPS spoofing and anti-spoofing work and his ingenious experimental demonstrations captured attentions from researchers, government agencies, and GNSS users worldwide by exposing the vulnerability of GPS technologies. There is no doubt in the GNSS community that Dr. Humphreys work propelled advancement of more secure and reliable GNSS technologies. He became an internationally recognized leading expert in using GPS to monitor ionosphere space weather phenomena by his pioneer effort in developing software radio-based GPS receivers for ionosphere scintillation monitoring. The ionosphere scintillation signal model developed by Dr. Humphreys is frequently in the research community to simulate GPS signals affected by space weather for receiver algorithm evaluations. His analysis on GPS

receiver carrier tracking algorithms design impacted a new generation of ionosphere scintillation monitoring receivers development. And his observations of GPS signal behavior during ionosphere scintillation brought new insights to the causes and mechanisms of ionosphere dynamics. Dr. Humphreys' publications are widely cited within the GNSS and ionosphere research community. I require all of my students to read his papers.

3. How would you assess Dr. Humphreys' development compared with others in his cohort at research-intensive universities?

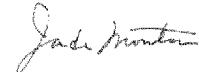
Dr. Humphreys is recognized as a leading researcher both nationally and internationally in the satellite navigation field. His work represents the state-of-the-art in the field. Compared to researchers at a similar state in their careers at research-intensive universities, Dr. Humphreys' work is impressively outstanding. This is evident by the numerous invited speeches he has given at various national and international conferences and media appearances.

4. What is your perspective on Dr. Humphreys' promise for further professional growth and leadership?

Dr. Humphreys is already a highly visible leader in the GNSS field, has pioneered important techniques, and made important discoveries. As a young researcher, he is already taking steps towards higher risk areas. I have no doubt that he will continue to make important contributions to the growing field of satellite navigation and applications.

Summary: Dr. Humphreys has demonstrated the qualification to be a leader in his field and he has been and will continue to be an asset for your institution. I offer my strongest support for Dr. Humphreys' promotion to Associate Professor with tenure.

Sincerely,



Jade Morton, PhD., IEEE Fellow  
Professor, Dept. of Electrical and Computer Engineering  
Miami University  
Oxford, OH 45056  
513-529-0749  
[Morton.jade@gmail.com](mailto:Morton.jade@gmail.com)

**Gonzales, Laurie**

---

**From:** Jade Morton <morton.jade@gmail.com>  
**Sent:** Saturday, July 26, 2014 4:03 PM  
**To:** Gonzales, Laurie  
**Subject:** Re: Reminder: Promotion and Tenure Review for Todd Humphreys  
**Attachments:** Humphreys PNT Evaluation by Morton.pdf; Morton 2page Biographical Sketch\_2014.pdf

Hi Laurie,

Attached are my external review for Dr. Todd Humphreys tenure and promotion evaluation. I also attached my 2-page vita.

Please do not hesitate to contact me if you need additional information.

Thank you,

Jade Morton

On Mon, Jul 14, 2014 at 10:19 AM, Gonzales, Laurie <[laurie.gonzales@austin.utexas.edu](mailto:laurie.gonzales@austin.utexas.edu)> wrote:

Good morning:

Thank you again for agreeing to write an external review for Dr. Todd Humphreys. Submission of your review and a brief bio or abbreviated CV by July 28<sup>th</sup> would be greatly appreciated. If there's anything additional you need to complete the review, please don't hesitate to contact me.

Cheers,

Laurie

---

*Laurie Gonzales*

*Department Manager*

*Aerospace Engineering and Engineering Mechanics*

*Cockrell School of Engineering*

*The University of Texas at Austin*

## Yu (Jade) T. Morton

Colorado State University  
Dept. of Electrical & Computer Engineering  
Fort Collins, CO 80523

Tel: (513) 907-9813  
Fax: (970) 491-2249  
E-mail: Morton.jade@gmail.com

### EDUCATION

Ph.D. (1991), Electrical Engineering, the Pennsylvania State University, University Park, PA  
M.S. (1987), Electrical Engineering, Case Western Reserve University, Cleveland, OH  
B.S. (1983), Physics, Nanjing University, Nanjing, China

### EMPLOYMENT

Colorado State University, Fort Collins, CO, Electrical & Computer Engineering Department  
Professor (2014-Present)  
Miami University, Oxford, OH, Electrical & Computer Engineering Department  
Professor (2009–2014), Associate Professor (2006–9), Assistant Professor (2000–6)  
The University of Michigan, Ann Arbor, MI  
Post-Doctoral Research Fellow (1991-1993), Space Physics Research Laboratories  
The Pennsylvania State University, University Park, PA  
Research Assistant (1987-1991), Electrical & Computer Engineering Department  
Case Western Reserve University, Cleveland, OH  
Research Assistant (1986-1987), Electrical Engineering & Applied Physics Department  
Nanjing University, Nanjing, China  
Faculty (1983-1985), Physics Department

### SELECTED RECENT RESEARCH GRANTS (Past 5 years)

- Acquisition of multi-constellation GNSS data collection arrays for low latitude ionospheric effects studies, \$177K, NSF, 2014-15.
- High latitude ionospheric scintillation studies using multi-constellation multi-band software GNSS receivers, \$396K, AFOSR, 2014-2017.
- Collaborative research and development program on navigation and time-keeping with AFRL/RYRN, \$715K, AFRL, 2008-14.
- Developing satellite signal parameter estimation algorithms for high-accuracy applications, \$650K, AFOSR, 2010-13.
- A study on the circulation and structure of metallic ions in the mid-latitude ionosphere. \$342K, NSF, 2007-12.
- Precise GPS signal tracking in interference and multipath environment using a multi-channel software receiver, \$288K, AFOSR, 2008-10.

### SELECTED RECENT AWARDS AND HONORS

- Fellow, IEEE, 2014
- Thurlow Award, Institute of Navigation (ION), 2014
- Distinguished Scholar Award, Miami University, 2013
- Woman's Leadership Award, Miami University, 2013
- Jennie Elder Suel Distinguished Woman of Color Award, Miami University, 2013
- Outstanding Researcher Award, School of Engineering & Applied Sci., Miami U., 2011
- Sigma Xi Researcher of the Year Award, Miami U., 2009

### SELECTED JOURNAL PUBLICATIONS (Past 5 Years)

- [1] *Jiao, Y., Y. Morton, S. Taylor, W. Pelgrum, "Characterization of high latitude ionospheric scintillation of GPS signals," Radio Sci., 48, doi:10.1002/2013RS005259, 2013.*
- [2] *Kou, Y., Y. Morton, "Oscillator frequency offset impact on software GPS receivers and correction algorithms," IEEE Trans. Aero. Elec. Sys., 49(4), 2158-2178, 2013.*
- [3] *Chen, X., Y. Morton, F. Dovis, "A computationally efficient iterative MLE for GPS AOA estimation," IEEE Trans. Aero. Elec. Sys., 49(4), 2707-2716, 2013.*

- [4] *Kauffman, K.*, J. Raquet, Y. Morton, D. Garmatyuk, "Real-time UWB-OFDM radar based navigation in unknown terrain," *IEEE Trans. Aero. Elec. Sys.*, 49(3), 1453-1466, 2013.
- [5] *Peng, S.*, Y. Morton, "A USRP2-based reconfigurable multi-constellation multi-frequency GNSS software receiver front end," *GPS Solutions*, DOI: 10.1007/s10291-012-0263-y, 2012.
- [6] Moore, R., Y. Morton, "Magneto-ionic polarization and GPS signal propagation through the ionosphere," *Radio Sci.*, 46, RS1008, doi:10.1029/2010RS004380, 2011.
- [7] *Park, J.*, R. Frese, D. Grejner-Brzezinska, Y. Morton, L. Gaya-Pique, "Ionospheric detection of the 25 May 2009 North Korean underground nuclear test," *Geophys. Res., Lett.*, 38, L22802, doi:10.1029/2011GL049430, 2011.
- [8] Garmatyuk, D., Y. Morton, X. Mao, "Radar and GPS system inter-operability with UWB-OFDM signals," *IEEE Trans. Aero. Elec. Sys.*, 47(1), 265-274, 2011.
- [9] *Brenneman, M.*, Y. Morton, "Functional bandwidth criterion for adaptive array performance," *IEEE Trans. Aero. Elec. Sys.*, 46(3), 1226-1235, 2010.
- [10] *Brenneman, M.*, Y. Morton, Q. Zhou, "GPS multipath detection with ANOVA for adaptive arrays," *IEEE Trans. Aero. Elec. Sys.*, 46(3), 1171-1185, 2010.
- [11] *Matteo, N.*, Y. Morton, "Higher-order ionospheric error at Arecibo, Millstone, and Jicamarca," *Radio Sci.*, 45, RS6006, doi:10.1029/2010RS004394, 2010.
- [12] Morton, Y., Q. Zhou, F. van Graas, "Assessment of second order ionosphere error in GPS range observables using Arecibo incoherent scatter radar measurements," *Radio Sci.*, 44, RS1002, doi:10.1029/2008RS003888, 2009.
- [13] *Xu, H.*, L. Yang, Y. Morton, M. Miller, "Mistiming performance analysis of the energy detection based ToA estimator for MB-OFDM," *IEEE Trans. Wireless Comm.*, 8(8), 3980-3984, 2009.
- [14] Morton, Y., M. Miller, J. Tsui, D. Lin, Q. Zhou, "GPS civil signal self-interference mitigation during weak signal acquisition," *IEEE Trans. Signal Processing*, 55(12), 5859-5893, 2007.

#### SELECTED invited PRESENTATIONS:

- [1] URSI General Assembly and Scientific Symposium (GASS), "Multi-constellation GNSS observations of equatorial ionospheric scintillation," Beijing, China, August, 2014.
- [2] White House Office for Science and Technology Auroral Workshop, "Research and education on Global Navigation Satellite Signals (GNSS) using HAARP," Washington DC, Jan. 2014.
- [3] The International Union of Radio Science (URSI) National Radio Science Meeting, "Multi-constellation multi-frequency GNSS scintillation," Boulder, CO, Jan. 2014.
- [4] American Geophysical Union meeting, "Analysis of GNSS receiver signal processing modification of scintillation parameters," San Francisco, CA, Dec. 2013.
- [5] Stanford University, "International monitoring of ionosphere," Palo Alto, CA, Nov. 2013.
- [6] National Academy of Science, "Basic issues related to ionospheric modification: GNSS scintillation," Washington DC, May 2013.
- [7] NOAA, "Satellite Navigation Signals for Ionospheric Remote Sensing Applications," Washington DC, May 2013.
- [8] Chinese Satellite Navigation Conference, "Global Navigation Satellite Signals for Space Weather Research," plenary presentation, Wuhan, China, May 2013.

#### SELECTED RECENT PROFESSIONAL SERVICES (past 5 years)

- Chair, ION Satellite Division (2012-14)
- Technical Committee Member, IEEE MTT Soc., Digital Signal Proc. Subgroup (since 2004)
- Associate Editor, IEEE Trans. Aerospace & Electronics (since 2008)
- Program Co-Chair, 2013 and 2015 ION Pacific Position, Navigation, and Timing (PNT) Conf.
- General Chair, 2013 ION Global Navigation Satellite Systems Conference
- Program Chair, 2012 ION Global Navigation Satellite Systems Conference
- General Chair, 2012 ION International Technical Meeting
- Program Chair, 2011 ION International Technical Meeting

Boris Pervan, Ph.D.

Professor  
Dept. of Mechanical, Materials  
& Aerospace Engineering

Armour College of Engineering  
Illinois Institute of Technology

Engineering I Building  
10 West 32nd Street  
Chicago, Illinois 60616-3793

Tel 312 567 3200  
Fax 312 567 7230  
Email: pervan@it.edu



July 27, 2014

Dr. Noel T. Clemens  
Department Chair and Bob R. Dorsey Professor in Engineering  
Aerospace Engineering and Engineering Mechanics  
University of Texas at Austin  
210 E. 24th St. Stop C0600  
Austin, TX 78712-1221

Dear Professor Clemens:

I am pleased to respond to your request for evaluation of Dr. Todd Humphreys' scholarship in regard to his case for tenure and promotion to the rank of Associate Professor. I am a tenured full Professor of Mechanical and Aerospace Engineering at the Illinois Institute of Technology. My own research focus is on high integrity Global Navigation Satellite Systems (GNSS). I am an elected Fellow of the Institute of Navigation (ION), and Editor of *NAVIGATION*, the Journal of the ION. I believe that I am capable of fairly evaluating Dr. Humphreys' research accomplishments.

I am familiar with Dr. Humphreys and his work through the many papers he and his graduate students have given at technical meetings and his refereed journal papers. I will state at the outset that his work has been uniformly excellent. His graduate students' presentations at conferences are always prepared to the highest standards. The journals in which he has published since arriving at UT Austin, including the *IEEE Transactions on Aerospace and Electronic Systems*, *IEEE Transactions on Signal Processing*, *IEEE/ASME Transactions on Intelligent Transportation Systems*, *Journal of Field Robotics*, and *NAVIGATION* are high quality archival journals with very stringent peer-review standards.

My first view of Dr. Humphreys' work was at the ION GNSS-2008 Meeting in Savannah, GA in September of 2008, where he presented the paper "Assessing the spoofing threat: development of a portable GPS civilian spoofer." I vividly recall this presentation, where he demonstrated to an astonished standing-room-only audience a seamless external takeover of a live GPS receiver. Although he had published a few papers earlier, I think it is fair to say that at that conference Dr. Humphreys made his 'grand entrance' into the GNSS research community. He has since been a rising star in the community. I can think of no other young faculty member in the field at a

similar career stage that even comes close to him in quality and prominence.

Perhaps nearly as important as the quality of Dr. Humphreys' work is his choice of research problems: ionospheric scintillation, navigation using signals of opportunity, and GNSS anti-spoofing, all of which are well-timed and vital research topics. Most notably, Dr. Humphreys is widely regarded nationally and internationally as a leader in GNSS anti-spoofing research. As editor-in-chief of a journal with a major focus on GNSS, I can attest that he is the first choice peer reviewer for any paper submission on anti-spoofing. He has himself published two excellent articles on the subject in the same journal in the last three years.

Dr. Humphreys' record of external funding while at UT-Austin has been very good. He has drawn over 1.7 million dollars of funding to the university since 2009. While not directly a measure of his scholarship, his strong funding record has allowed him to create and support a successful research program. This is plainly evident through his inclusion of numerous graduate students in his research activities. He has graduated 2 Ph.D. students and 2 M.S. students, and currently is advising 5 students, 3 Ph.D. and 2 M.S.

Overall, Dr. Humphreys has disseminated his research in 16 journal papers (published or accepted) and has another 2 in review. He also has published 41 conference papers. I believe that his publication record is very strong, and that in particular, his prolific journal article production rate while at UT-Austin is a very positive indicator for the future.

With regard to professional involvement in his fields of research, I know that Dr. Humphreys has been an active member of the ION. He has served as a track chair and session chair numerous times at ION meetings. He is well known and respected by the navigation community at large.

In summary, I believe that Dr. Humphreys' record of scholarly accomplishments is outstanding and that he has considerable momentum for future research. Without a doubt, I believe that he would qualify for tenure at any major research institution, and that UT-Austin is fortunate to have him. I recommend him strongly for promotion.

Should you have further questions feel free to contact me.

Sincerely,



Boris Pervan

**Gonzales, Laurie**

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**From:** Boris Pervan <pervan@iit.edu>  
**Sent:** Sunday, July 27, 2014 10:45 PM  
**To:** Gonzales, Laurie  
**Subject:** Re: Todd Humphreys - External Review Request  
**Attachments:** Todd Humphreys Letter.pdf; ATT00001.htm; Pervan 2 page CV.pdf; ATT00002.htm

Hello Laurie,

Attached please find my letter of evaluation for Dr. Humphreys and a 2-page version of my CV.

**Boris Pervan**  
Professor of Mechanical and Aerospace Engineering  
Illinois Institute of Technology

MMAE Dept, E1 252C  
10 W 32nd St, Chicago, IL 60616  
Ph: 312 567 3200

## BORIS PERVAN

### **Education**

University of Notre Dame	Aerospace Engineering	B.S. (1986)
California Institute of Technology	Aeronautics	M.S. (1987)
Stanford University	Aeronautics and Astronautics	Ph.D. (1996)

### **Experience**

Illinois Institute of Technology, Chicago, Illinois		
Professor of Mechanical and Aerospace Engineering		2010-present
Associate Professor of Mechanical and Aerospace Engineering		2005-2010
Assistant Professor of Mechanical and Aerospace Engineering		1999-2005
Stanford University, Stanford, California		
Research Associate, Hansen Experimental Physics Laboratory		1996-1998
Research Assistant, Department of Aeronautics and Astronautics		1992-1996
Teaching Assistant, Department of Aeronautics and Astronautics		1991
Hughes Aircraft Company, El Segundo, California		
Systems Engineer, Space and Communications Group		1987-1990

### **Honors and Awards**

- Elected Fellow of Institute of Navigation (2010)
- Sigma Xi Award for Outstanding Research and Scholarship, IIT (2012, 2005)
- Ralph Barnett Outstanding Teaching Award, IIT MMAE Dept. (2009, 2002)
- Caterpillar Excellence in Research Award, IIT MMAE Dept. (2007)
- University Excellence in Teaching Award, IIT (2005)
- IEEE M. Barry Carlton Award (1999)
- RTCA William E. Jackson Award (1996)
- Guggenheim Fellowship, Caltech (1986-87)
- Albert J. Zahm Prize in Aeronautics, Notre Dame (1986)

### **Selected Publications (from last 5 years)**

- Jing, J., Khanafseh, S., Chan, F.-C., Langel, S., and Pervan, B., "Carrier Phase Null Space Monitor for Ionospheric Gradient Detection," accepted for publication in *IEEE Transactions on Aerospace and Electronic Systems*.
- Chan, F.-C., Joerger, M., and Pervan, B., "Stochastic Modeling of Atomic Receiver Clock for High Integrity GPS Navigation," accepted for publication in *IEEE Transactions on Aerospace and Electronic Systems*.
- Langel, S., Khanafseh, S., and Pervan, B. "Bounding Integrity Risk for Sequential State Estimators in the Presence of Stochastic Modeling Uncertainty," *Journal of Guidance, Control, and Dynamics*, Vol. 37, No. 1, January-February 2014.

Joerger, M., and Pervan, B., "Kalman Filter-Based Integrity Monitoring Against Sensor Faults," *Journal of Guidance, Control, and Dynamics*, Vol. 36, No. 2, March-April 2013.

Joerger, M., Neale, J., Datta-Barua, S., and Pervan, B., "Ionospheric Error Modeling for Carrier Phase-Based Multi-Constellation Navigation Systems," *IEEE Transactions on Aerospace and Electronic Systems*, Vol. 49, No. 1, January 2013.

Rife, J. and Pervan, B., "Overbounding Revisited: Discrete Error-Distribution Modeling for Safety-Critical GPS Navigation," *IEEE Transactions on Aerospace and Electronic Systems*, Vol. 48, No. 2, April 2012.

Khanafseh, S., and Pervan, B., "Detection and Mitigation of Reference Receiver Faults in Differential Carrier Phase Navigation Systems," *IEEE Transactions on Aerospace and Electronic Systems*, Vol. 47, No. 4, October 2011.

Chan, F.-C. and Pervan, B., "High Integrity GPS/INS Integrated Navigation with Error Detection and Application to LAAS," *Journal of Navigation*, Vol. 64, No. 3, July 2011.

Gratton, L., Joerger, M., and Pervan, B., "Carrier Phase Relative RAIM Algorithms and Protection Level Derivation," *Journal of Navigation*, Vol. 63, No. 2, April 2010.

Khanafseh, S. and Pervan, B., "A New Approach for Calculating Position Domain Integrity Risk for Cycle Resolution in Carrier Phase Navigation Systems," *IEEE Transactions on Aerospace and Electronic Systems*, Vol. 46, No. 1, January 2010.

Joerger, M. and Pervan, B., "Measurement-level Integration of Carrier Phase GPS and Laser Scanner for Outdoor Ground Vehicle Navigation," *Journal of Dynamic Systems, Measurement, and Control*, Vol. 131, March 2009.

Walter, T., Enge, P., Blanch, J., and Pervan, B., "Worldwide Vertical Guidance of Aircraft Based on Modernized GPS and New Integrity Augmentations," *Proceedings of the IEEE*, Vol. 96, No. 12, December 2008.

### **Research Projects**

Directed radio-navigation research activities as PI on research grants, contracts and cooperative agreements in excess of 6 million dollars (own share) while at IIT. These projects have been sponsored by the Federal Aviation Administration, U.S. Navy, U.S. Air Force, the Boeing Co., Northrop-Grumman, Raytheon, and IIT Research Institute.

### **Professional Activities and Service**

Editor of *NAVIGATION*, Journal of the Institute of Navigation

Session Chair at numerous IEEE and ION technical conferences

Federal Aviation Administration (FAA):

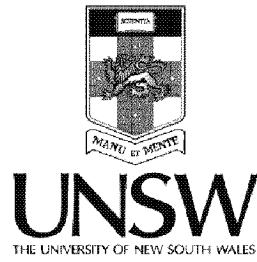
Advanced Receiver Autonomous Integrity Monitoring (ARAIM) Working Group

GPS Evolutionary Architecture Study (GEAS) Panel

Key Technical Advisory (KTA) Panel for the Local Area Augmentation System (LAAS)

LAAS Integrity Panel (LIP)

Noel Clemens, Department Head  
Aerospace Engineering & Engineering Mechanics  
Cockrell School of Engineering  
The University of Texas at Austin



20 July 2014

**Re: Report on Dr Todd Humphreys, with regards to the granting of tenure and his promotion to Associate Professor**

I am pleased to be able to provide an assessment with regards to Dr Humphrey's research standing and achievements in the context of his application for promotion to Associate Professor, and tenure, at The University of Texas at Austin. I have read the promotion criteria, Dr Humphreys' CV, and some of the papers he has authored, as forwarded to me in a recent email.

Let me first introduce myself. My name is Chris Rizos, and I am the Professor of Geodesy & Navigation, School of Civil & Environmental Engineering, at the University of New South Wales (UNSW), Sydney, Australia. I am currently the President of the International Association of Geodesy (IAG) 2011-2015 (<http://www.iag-aig.org>), have been a member of the Executive and of the Governing Board of the International GNSS Service (IGS) since 2004 (<http://www.igs.org>), and have been co-chair of the Multi-GNSS Asia Steering Committee since 2010 (<http://www.multignss.asia>). I am a Fellow of the IAG, a Fellow of the U.S. Institute of Navigation (ION), and a Fellow of the Australian Institute of Navigation. My short CV can be viewed at our department's web site <http://www.engineering.unsw.edu.au/civil-engineering/staff/chris-rizos>.

I have been researching GPS technology and applications, as well as other geodesy topics since the mid-1980s. My research interests span several disciplines – Navigation, Surveying and Geodesy. Each discipline has its own culture, its own professional and scientific societies, and each runs its own conferences (and other activities) in isolation from each other. I mention this because I first met Dr Humphreys in 2010, in Newcastle, U.K. at the IGS Analysis Workshop, where he presented a talk on software-defined Global Navigation Satellite System (GNSS) receivers. Dr Humphreys made a very good impression on GPS/GNSS geodesists, who typically treat receivers as "black boxes". Here was a young academic able to communicate on the subtle workings inside the receiver "box". Ever since then I have been aware of Dr Humphreys' work via the technology press, reporting on his various (attention-grabbing) GPS jamming and spoofing activities. This work has been ground-breaking not just in a technological sense, but in the impact it has had on discussions concerned with GPS (and GNSS in general) vulnerability of positioning and timing receivers.

Dr Humphreys is one of those rare academics whose research gets noticed by more than just his immediate peers. From samples of publications, his CV, as well as his appearance at top conferences such as those organised by the IEEE and ION, it is clear that Dr Humphreys is held in high regard, as a world class academic researcher in the area of GNSS receiver signal processing. This field is quite broad, and there are many opportunities for him (and his research team) to make significant contributions. I have no doubt that Dr Humphreys will be very successful in this regard. I expect he will attract graduate students, research grants, and numerous accolades and honours. But I sense that Dr Humphreys has something of a "showman" about him, and this is in no way intended as a slight.

Dr Humphreys' work is innovative both as a researcher and as a scholar. We are currently living in exciting times, where technologies such as GPS/GNSS are increasingly recognised for their unique positioning, navigation and timing (PNT) capability. Everyday we hear of new applications for this technology. Yet there is also an increasing concern about the vulnerability of GPS/GNSS to intentional and unintentional interference and "spoofing". Dr Humphreys understands this, and has been able to dramatically demonstrate this vulnerability through the spoofing of navigation systems on a UAV and a yacht. The way that this was done, by eschewing reporting this only in the scientific literature, was an example of extraordinary "scholarship". (Of course it was also a shrewd strategy that will no doubt attract significant research funding... however I do not see this as being an issue of concern.)

This combination of assiduously publishing in the best journals, in presenting at top IEEE and ION conferences, and being reported in the "trade" (i.e. GNSS and PNT) press, has ensured that Dr Humphreys' development (and reputation) has been little short of meteoric. Dr Humphreys has the "world at his feet", and to think he is still only an Assistant Professor. We look forward to inviting him to speak to us here at UNSW in the coming year(s)!

In summary, Dr Humphreys has clearly demonstrated the high-level researcher skills and scholarship worthy of an Associate Professor at a research-intensive university. I am confident that he will continue to make valuable contributions to the fields of GNSS receiver design, signal processing, cryptography and anti-spoofing studies. I have no hesitation at all in recommending Dr Humphreys for tenure and for promotion to the position of Associate Professor. He has the potential to truly put your department "on the map" as far as GNSS studies is concerned.

Yours sincerely,



Chris Rizos  
Professor, Geodesy & Navigation  
School of Civil & Environmental Engineering

**Gonzales, Laurie**

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**From:** Chris Rizos <c.rizos@unsw.edu.au>  
**Sent:** Friday, July 18, 2014 11:47 PM  
**To:** Gonzales, Laurie  
**Subject:** Re: Reminder: Promotion and Tenure Review for Todd Humphreys  
**Attachments:** HumphreysLet07-14.pdf

Please find attached my referee's letter.

I hope this will prove useful in your deliberations.

CR

On 15 Jul 2014, at 12:19 am, Gonzales, Laurie <laurie.gonzales@austin.utexas.edu> wrote:

Good morning:

Thank you again for agreeing to write an external review for Dr. Todd Humphreys. Submission of your review and a brief bio or abbreviated CV by July 28<sup>th</sup> would be greatly appreciated. If there's anything additional you need to complete the review, please don't hesitate to contact me.

Cheers,  
Laurie

---

*Laurie Gonzales  
Department Manager  
Aerospace Engineering and Engineering Mechanics  
Cockrell School of Engineering  
The University of Texas at Austin  
(512) 471-5145 Direct  
(512) 471-7593 Main*

---

Chris Rizos  
Professor, Geodesy & Navigation  
Surveying & Geospatial Engineering  
School of Civil & Environmental Engineering  
UNSW Australia (The University of New South Wales)  
Sydney NSW 2052 AUSTRALIA  
President, International Association of Geodesy (IAG)  
Tel: +61 (2) 93854205  
Mob: 0405-848889 (Australia)  
Fax: +61 (2) 9385 6139  
Email: [c.rizos@unsw.edu.au](mailto:c.rizos@unsw.edu.au)  
WWW: W: <http://www.engineering.unsw.edu.au/civil-engineering/staff/chris-rizos>  
Twitter: [http://twitter.com/c\\_rizos](http://twitter.com/c_rizos)

CRICOS Provider no. 00098G

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Effective from 1 March 2013, the School of Surveying & Geospatial Engineering has been integrated within the School of Civil & Environmental Engineering, at the University of New South Wales.

# **CURRICULUM VITAE**

**Name:**

Chris RIZOS

**Affiliation:**

School of Civil & Environmental Engineering  
 UNSW, Sydney NSW 2052  
 Tel: +61-2-93854205; Fax: +61-2-93856139  
 Email: c.rizos@unsw.edu.au

**Academic Qualifications & Awards:**

- BSurv (Hons.1), UNSW, 1975; PhD, UNSW, 1980
- University Medal, UNSW, 1975
- Commonwealth Postgraduate Research Scholarship, 1975-78
- Fulbright Fellowship (Postgraduate Category), 1977-78; Rothmans Fellowship, 1979
- Alexander von Humboldt Fellowship, 1981-83, 1991
- Fellow of the Australian Institute of Navigation, 1999
- Fellow of the International Association of Geodesy, 1999
- Fellow of the U.S. Institute of Navigation, 2012
- Honorary Professor, Wuhan University, P.R. China, 2006

**Brief Biography:**

Chris Rizos joined the academic staff of the School of Surveying, UNSW, in 1987, and was promoted to Professor in 2001. Chris was Head of the School of Surveying & Geospatial Engineering (formerly School of Surveying), UNSW, from 2004 until 2013 when it merged with the School of Civil & Environmental Engineering. Chris has been researching the technology and high precision applications of GPS since 1985, and has authored or co-authored over 600 journal and conference papers. Chris established the Satellite Navigation and Positioning Lab at UNSW in the early 1990s - Australia's premier academic R&D group for GNSS and wireless positioning technology and applications.

**Professional & Scientific Duties:**

- President of the International Association of Geodesy (IAG), 2011-2015
- Member of the joint IAG/IHO Advisory Board for technical aspects of the UN Law of the Sea (ABLOS), 1995-2011; Chair 2009-2010
- Member of the Council of the Australian Institute of Navigation, 1994-2000
- Member of the AuScope Geospatial Steering Committee, 2007-2012
- Member of the APREF Steering Committee, 2009+
- Co-chair of the Multi-GNSS Asia Steering Committee, 2009+
- Member of the Executive Committee, International Centre for Research & Development of Satellite Navigation in S.E. Asia (NAVIS), Hanoi, Vietnam, 2012+
- Member of the National Committee for Earth Sciences of the Australian Academy of Sciences, 2012-2015
- Co-organiser and member of Organising Committee of the National Satellite Navigation Technology Symposia (originally jointly with QUT, then with the IGNSS Society), in 1993, 1995, 1997, 1999, 2001, 2003, 2006, 2007, 2009, 2011, 2013
- Science Program Manager for positioning-related topics in the Cooperative Research Centre for Spatial Information (<http://www.crcsi.com>), 2002-2009
- Member of the Australian GNSS Coordination Committee, mid-2004 to mid-2006
- Member of the ICSM Geodesy Technical Sub-Committee, 2004+
- Member of Editorial Boards "GPS Solutions", "Journal of Geospatial Eng.", "Journal of Global Positioning Systems", & "Inside GNSS; Editor-in-chief "Journal of Applied Geodesy"
- Member of the Governing Board of the International GNSS Service (IGS), 2004+; Member of the Executive Committee 2006+
- Reviewer of grant applications for research councils in Australia, USA, Canada, South Africa, New Zealand, and Hong Kong.

**Research Interests:**

- Carrier phase-based kinematic GPS/GNSS positioning over short, medium and long baselines: Research projects include combined multi-GNSS data processing algorithms, multi-reference station techniques, network-RTK, special techniques for long-range positioning applications.  
□□□□
- Development of GPS/GNSS-based deformation monitoring systems, low-cost GPS systems for survey applications and building monitoring. □□□□
- Modern geodetic datum studies for upgrade of Australian Geodetic Datum using GNSS and ITRF global geodetic products. □□□□
- Innovative geodetic techniques, integration of GNSS with Interferometric SAR techniques, guidelines for the development of multi-functional CORS networks, “smart” GNSS receivers.  
□□□□
- New positioning technologies, indoor positioning, pseudolites, Locata, WiFi & Mobilephone positioning, GNSS+INS integration (and other sensors), Location Based Services applications.

**Grants:**

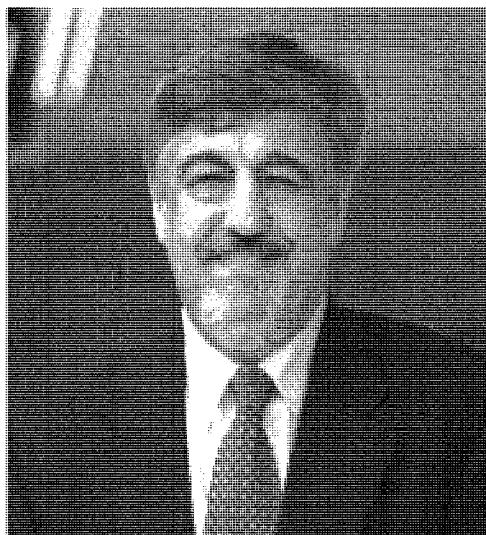
CI in over 30 ARC grants in the last 20 years. In the last 5 years Chris Rizos has been a CI on research grants that have included 4 from the ARC; 3 from the CRC for Spatial Information; 2 from the Australian Space Research Program; and 3 from UNSW or federal government schemes; for a total value of over \$6M.

**Publications:**

Over 600 publications and conference papers in the areas of physical geodesy, satellite oceanography, satellite geodesy, GPS/GNSS and navigation technologies and applications (view full list at [http://www.gmat.unsw.edu.au/snap/staff/rizos\\_papers.htm](http://www.gmat.unsw.edu.au/snap/staff/rizos_papers.htm)). Co-author of the book “Positioning Systems for Intelligent Transportation Systems (ITS)” (Artech House), and a monograph “Principles and Practice of GPS Surveying”. Associate Editor of the book “Manual of Geospatial Science and Technology” (Taylor & Francis, 1<sup>st</sup> & 2<sup>nd</sup> eds).

C.R.

20 July 2014



Jet Propulsion Laboratory  
California Institute of Technology

Noel T. Clemens  
Department Chair and Bob R. Dorsey Professor in Engineering

Dear Prof. Clemens,

Here are my responses to the questions you posed. Thanks for giving me the opportunity to contribute my input, which is 100% positive.

1. Do you know Dr. Humphreys, and if so, for how long and under what circumstances?

Yes, we met in 2008 when we were co-chairs of the IGS Workshop 2008 session "Progress in receiver calibrations & future developments". He impressed me with his diligent work on everything needed to make our session a success. Since then, we collaborated on a single AGU poster on the same topic, and I have followed his work through the technical literature.

2. What are the original, innovative, and/or important contributions that he has made in his field of research? Have his publications influenced the thinking of, or the methods used by, others in your field?

I do not pretend to know of all of Dr. Humphreys' contributions, but I am aware of his pioneering work which identified a credible threat of spoofing to GNSS signals. His work in this topic was very comprehensive, ranging from theoretical derivations to practical demonstrations. The most notorious of these was his demonstration of a spoofing signal "taking control" of a UAV. I have enjoyed reviewing the publications attached to your request.

I consider Dr. Humphrey's writing to be stellar. His papers show familiarity with other work in the field, and always relate useful new information. His writing is clear and logical. His papers contain elegant theoretical derivations, but also are tied to practical hardware constraints.

I believe Dr. Humphrey's work has certainly influenced the extensive field of GNSS user, particularly those who require high assurance of signal integrity. I believe the request for him to testify to the US Congress on GPS spoofing makes this clear.

3. How would you assess Dr. Humphreys' development compared with others in his cohort at research-intensive universities?

I am not in the best position to judge this, but from what I have seen in his technical work and what I read of his contributions to the Radionavigation Laboratory I imagine his development must be near the top of his cohort. I consider him to be a star.

4. What is your perspective on Dr. Humphreys' promise for further professional growth and leadership?

I have no difficulty in saying Dr. Humphreys will continue to succeed in developing interesting new advances in radionavigation technology, and I have a strong belief that he will be an excellent leader and teacher.

We would be grateful for any additional comments you might have. The more specific you can be in your comments, the more helpful your evaluation will be.

Jet Propulsion Laboratory  
California Institute of Technology

I may not have additional substantive comments, but I have to say I skipped getting a coffee refill at times in order to get to the next paragraph of some of Todd's papers. I'd like to re-emphasize how well those were written, with the correct amount of motivation, careful definition of terms, and from what I can see, correct results, that are discussed in relation to what can be realized with practical implementations. This is a very impressive combination!

Sincerely,

  
Larry Young  
25 July 2014

Lawrence E. Young, PhD  
GPS Systems Group Supervisor  
138-212 Jet Propulsion Laboratory  
4800 Oak Grove Drive  
Pasadena, CA 91109  
Office 818 354-5018

**Gonzales, Laurie**

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**From:** Young, Lawrence E (335F) <lawrence.e.young@jpl.nasa.gov>  
**Sent:** Friday, July 25, 2014 2:16 PM  
**To:** Gonzales, Laurie  
**Subject:** Re: Reminder: Promotion and Tenure Review for Todd Humphreys  
**Attachments:** Page 1.jpg; Page 2.jpg; ley vita for UTA.doc

Laurie,

I have attached a scanned version of my review, and a brief bio. Please let me know if you need additional information, and I will be happy to assist you.

Best regards,  
Larry Young

--

Lawrence E. Young, PhD  
GPS Systems Group Supervisor  
138-212  
Jet Propulsion Laboratory  
4800 Oak Grove Drive  
Pasadena, CA 91109  
Office 818 354-5018

From: "Gonzales, Laurie" <laurie.gonzales@austin.utexas.edu>  
Date: Mon, 14 Jul 2014 14:19:44 +0000  
To: "<Undisclosed recipients;>"  
Subject: Reminder: Promotion and Tenure Review for Todd Humphreys

Good morning:

Thank you again for agreeing to write an external review for Dr. Todd Humphreys. Submission of your review and a brief bio or abbreviated CV by July 28th would be greatly appreciated. If there's anything additional you need to complete the review, please don't hesitate to contact me.

Cheers,  
Laurie

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Laurie Gonzales  
Department Manager  
Aerospace Engineering and Engineering Mechanics  
Cockrell School of Engineering  
The University of Texas at Austin  
(512) 471-5145 Direct  
(512) 471-7593 Main

**Lawrence E. Young**  
Supervisor of GPS Systems Group  
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818-354-5018

**Education**

B. A. Physics, Johns Hopkins University, 1970  
M. S. Nuclear Physics, State Univ of New York at Stony Brook, 1972  
PhD. Nuclear Physics, State Univ of New York at Stony Brook, 1975

**WORK SUMMARY:**

Dr. Larry E. Young has developed radiometric technology at Caltech's Jet Propulsion Laboratory since 1978, currently leading a group developing precision GNSS receivers. Specific areas of group research include satellite GNSS receivers, receiver-controlled antenna arrays, multipath mitigation, sub-nanosecond clock synchronization, and sub-cm formation flying. Ongoing work includes developing GNSS flight receivers to pioneer science applications including radio occultations, and exploitation of surface reflections of GNSS and other signals to remotely sense properties of the Earth surface.

**PUBLICATIONS**

**SUMMARY:**

36 refereed papers, 59+ conference proceedings, 30 NASA tech briefs, 6 US patents, chaired 8 science sessions at international meetings, developed and taught 4 classes on GPS, received 14 NASA awards, lead or served on 9 committees, boards, and tiger teams, and expert witness on two GPS-related trials..

**Gonzales, Laurie**

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**From:** Gonzales, Laurie  
**Sent:** Monday, June 23, 2014 2:47 PM  
**To:** Grejner-Brzezinska, Dorota A.  
**Subject:** RE: Todd Humphreys - External Review Request

Thanks for considering our invitation. That would be too late for our committee to consider your review as part of the package.

Cheers,  
Laurie

**From:** Grejner-Brzezinska, Dorota A. [mailto:[grejner-brzezinska.1@osu.edu](mailto:grejner-brzezinska.1@osu.edu)]  
**Sent:** Monday, June 23, 2014 1:58 PM  
**To:** Gonzales, Laurie  
**Subject:** Re: Todd Humphreys - External Review Request

The soonest I could perform this review would be the first week of September. I am sorry, but I am already fully committed for the next two months.

Cheers,  
Dorota



Dorota A. Grejner-Brzezinska  
Professor and Chair  
Fellow, Institute of Navigation  
College of Engineering Department of Civil, Environmental and Geodetic Engineering  
470 Hitchcock Hall, 2070 Neil Ave., Columbus, OH 43210  
Office: 614-292-3455  
Secondary: 614-292-8787  
Email: [grejner-brzezinska.1@osu.edu](mailto:grejner-brzezinska.1@osu.edu)  
Web: [ceg.osu.edu/people/grejner-brzezinska.1](http://ceg.osu.edu/people/grejner-brzezinska.1)

**From:** <Gonzales>, Laurie <[laurie.gonzales@austin.utexas.edu](mailto:laurie.gonzales@austin.utexas.edu)>  
**Date:** Monday, June 23, 2014 at 9:26 AM  
**To:** Dorota Brzezinska <[grejner-brzezinska.1@osu.edu](mailto:grejner-brzezinska.1@osu.edu)>  
**Subject:** RE: Todd Humphreys - External Review Request

Would an extended deadline help you to complete the review or would you still need to decline?

Thanks,  
Laurie

**From:** Grejner-Brzezinska, Dorota A. [mailto:[grejner-brzezinska.1@osu.edu](mailto:grejner-brzezinska.1@osu.edu)]  
**Sent:** Monday, June 23, 2014 8:07 AM

**To:** Gonzales, Laurie  
**Subject:** Re: Todd Humphreys - External Review Request

Thank you for your kind invitation, however, due to prior commitments, I am unable to provide the review within the required deadline.

I apologize for any inconvenience that it may cause.

Sincerely,  
db



Dorota A. Grejner-Brzezinska  
Professor and Chair  
Fellow, Institute of Navigation  
College of Engineering Department of Civil, Environmental and Geodetic Engineering  
470 Hitchcock Hall, 2070 Neil Ave., Columbus, OH 43210  
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Web: [ceg.osu.edu/people/grejner-brzezinska.1](http://ceg.osu.edu/people/grejner-brzezinska.1)

**From:** <Gonzales>, Laurie <[laurie.gonzales@austin.utexas.edu](mailto:laurie.gonzales@austin.utexas.edu)>

**Date:** Monday, June 16, 2014 at 12:09 PM

**To:** Dorota Brzezinska <[grejner-brzezinska.1@osu.edu](mailto:grejner-brzezinska.1@osu.edu)>

**Subject:** Todd Humphreys - External Review Request

Greetings, Dr. Grejner-Brzezinska:

Please find attached a letter from Dr. Noel Clemens, Chair of the Department of Aerospace Engineering and Engineering Mechanics at The University of Texas at Austin, requesting your assistance in serving as an external reviewer for promotion to associate professor and tenure for Dr. Todd Humphreys. The review report would be due by July 28, 2014. If you are able to help us with this review, could you please let me know via email by June 20<sup>th</sup>?

Thank you,  
Laurie

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Laurie Gonzales  
Department Manager  
Aerospace Engineering and Engineering Mechanics  
Cockrell School of Engineering  
The University of Texas at Austin  
(512) 471-5145 Direct  
(512) 471-7593 Main